Historic, archived document

Do not assume content reflects current scientific knowledge, policies, or practices.

1
Ag84M
cop.4

OCT 10 1941

UNITED STATES
DEPARTMENT OF AGRICULTURE
MISCELLANEOUS PUBLICATION NO. 433

Washington, D. C. September 1941

ERADICATION OF THE PARLATORIA DATE SCALE IN THE UNITED STATES

By B. L. **Boyden**, *senior entomologist, Division of Fruit Insect Investigations, Bureau of Entomology and Plant Quarantine*[1]

CONTENTS

	Page
Introduction	1
Establishment of the date-growing industry in the Southwest	2
Introduction of date scales	4
Early control efforts	5
Development of eradication program	6
Progress in eradication 1914 to 1927, inclusive	8
Arizona	8
Texas	9
California, Imperial Valley	9
California, Coachella Valley	9
Situation in the date-growing area at the close of 1927	12
Survey of the date-growing area	12
General information on the scale	18
Description	18
Life history	21
Parasites	21
Economic status	21
Host plants	21
Dissemination	24
Review of former eradication methods	26
The red date scale and the problem of its eradication	31
Conclusions drawn from the survey and review of former eradication methods	34
Reorganization of the date scale project	36
Eradication procedure	37
Survey	38
Inspection	40
Fan and Canary Island palm inspection	45
Records	46
Treatment	47
Quarantine	47
Clean-up work	47
Eradication in the individual planting	49
Boyer garden	50
Holmes garden, block 3	53
Middleton garden	54
Abandoned seedling planting	55
Progress in eradication January 1, 1928, to June 30, 1936	55
Summary	59

INTRODUCTION

The first successful importation of date palms (*Phoenix dactylifera* L.) from the Old World in 1890 marked the beginning of the date industry in the Southwest. These palms, and many palms imported later, were infested with a scale insect, then unknown to science but later classified as *Parlatoria blanchardi* (Targ.). This scale was early recognized as a limiting factor in the commercial production of dates, and an investigation of the insect was begun, the objective being eradication.

---

[1] Much of the information on the early history of the eradication work and of the date industry was obtained from A. J. Shamblin, who has been connected with the industry since 1900 in various capacities—in charge of the eradication of the parlatoria date scale for the United States Department of Agriculture, superintendent of the U. S. Department of Agriculture date garden at Indio, Calif., and date grower. The photographs from which figs. 9, 10, and 21 were made were kindly supplied by Dewey C. Moore, of the Bureau of Plant Industry.

This publication describes the development of the method of treatment and of the eradication program, including the cooperative efforts of date growers and governmental agencies, which led to the extermination of the scale in the date-growing areas of the Southwest.

ESTABLISHMENT OF THE DATE-GROWING INDUSTRY IN THE SOUTHWEST

Date palms were first grown in the Southwest from seed brought in by the Spanish missionaries and explorers. Later the early settlers used seed for dooryard plantings. In the coastal areas climatic conditions, although seemingly favorable to the vegetative growth of the palm, were not favorable for the production of fruit.

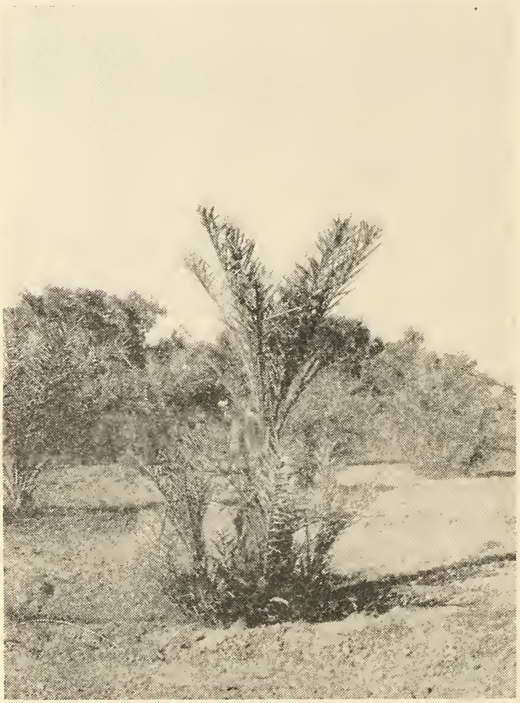

FIGURE 1.—Offshoots at base of date palm. The palm had been recently defoliated.

In the hot desert areas a few palms produced excellent fruit and interest was stimulated in the possibilities of date growing. Since approximately 50 percent of the palms grown from seed are males and produce no fruit and the fruit of the females vary widely in quality from palm to palm and from the parent palm, little progress was made in commercial date growing until Old World varieties were introduced and satisfactory methods of propagation from offshoots developed. A date palm offshoot, or sucker, is a vegetative growth from a bud, usually at the base of the trunk of the parent palm, and is in fact a small palm when rooted. When an offshoot is cut from a palm and planted, the resulting palm is of the same sex as the parent and also has similar vegetative and fruiting characteristics (figs. 1 and 2).

In 1890 the first successful importation of date palms from the Old World was made by the Division of Pomology, of the United States Department of Agriculture. In July of that year 9 date palm offshoots from Algeria and 59 from Egypt were received in Washington and in October were forwarded to cooperators in California, New Mexico, and Arizona. In August of the next year 6 additional offshoots were received in Washington and sent to the Southwest. Ten of the offshoots were planted on the experimental farm of the University of Arizona near Phoenix (*12*).[2] Nine of them survived and in 1928 were growing on the original planting site. The history of the remainder of the offshoots is not entirely clear, but it is probable that the survivors are now in the Coachella Valley in California.

No further importations were made until 1899 and 1900, when 447 offshoots were received and 391 of them were planted in a new date experimental station near Tempe, under a cooperative agreement between the United States Department of Agriculture and the Arizona Agricultural Experiment Station. Twenty-one of the offshoots in this shipment were planted at the old experimental farm near Phoenix and 35 were divided between the Pomona and Tulare substations of the California Agricultural Experiment Station (*13*). Between 1900 and 1908 other importations of offshoots for experimental purposes were made and gardens were established at Mecca, Calif., in 1904. Yuma, Ariz., in 1905, and Indio, Calif., in 1907. During this period commercial plantings of imported offshoots were made at Mecca and at Heber, Calif.

FIGURE 2.—Recently planted offshoots of date palm. Some growth had been made since planting.

From 1911 to 1915 between 30,000 and 35,000 offshoots were received in the Coachella Valley from the Old World. A few of these were used for experimental purposes, but most of them were imported by growers for commercial plantings. One lot of 2,720 was reshipped to Yuma and approximately 700 were sold in the Imperial Valley, where 2 plantings were established. No importations were made from 1916 to 1919 but during the next 3 years approximately 12,000 offshoots were received, which were planted in quarantine nurseries in California and Arizona. No further large importations were made, although a few offshoots were later brought in for experimental purposes.

---

[2] Italic figures in parentheses refer to Literature Cited, p. 61.

For a few years, when the first commercial importations of offshoots were being made, hundreds of thousands of date seeds were planted. Most of the seed was planted thickly in rows, and it was planned to thin out the palms by removing the superfluous males and the females producing poor fruit and leaving only the females producing good fruit and enough males to produce an adequate supply of pollen. Some of these seedling plantings were dug up before thinning, others were abandoned and died, and still others, supplied with underground water or waste irrigation water, survived and became veritable jungles. Other plantings were thinned and developed into gardens, some were later abandoned, and others continued as commercial gardens. Many palms in other seedling plantings were removed, leaving only a few for ornamentals or to supply the household with fruit.

Although the date industry may be said to have had its beginning with the introduction of standard-variety palms, the commercial development of the industry began about 1920, after a successful method of handling offshoots had been worked out. Judging from the reports of the survey in 1928, there were approximately 13,250 standard palms in the date-growing area in 1920—10,000 in the Coachella Valley, 700 in the Imperial Valley, 1,000 in the Salt River Valley, 1,500 in the Yuma Valley, and 50 in an experimental planting at Laredo, Tex.

During the 1928 survey approximately 68,500 standard palms were recorded, 55,277 of them in the Coachella Valley, where there had been considerable interest in date growing since the early commercial importations. In the Salt River Valley and the Yuma Valley 7,562 and 3,434 standard palms were located. Growers' interest began in these localities after a satisfactory method of removing offshoots from palms and starting them in the field had been developed. In the Imperial Valley approximately 2,000 standard palms were located and in Texas about 150 in experimental plantings. Growers' interest developed later in these localities. With a large supply of offshoots available in 1928 the industry showed all indications of rapid development.

INTRODUCTION OF DATE SCALES

When the 1890 shipment of offshoots was received in Washington, the palms were found to be infested with two scale insects. One of these, a diaspine scale, was at first thought to be *Parlatoria zizyphus*, but it subsequently was recognized as distinct and was described by Cockerell (*1*) in 1895 as *P. victrix*. Previously, however, in 1892, Targioni Tozzetti (*11*) had described a new diaspine scale from date palms from North Africa under the name *Aonidia blanchardi*, and in 1899 Cockerell (*2*) recognized that his *victrix* was identical with Targioni Tozzetti's species and established the scientific name of the date palm scale as *Parlatoria blanchardi* (Targ.).

The other scale insect was first taken in this country by C. L. Marlatt on August 7, 1890, in Washington on the palms imported from Algeria and was also new to science. It was described by Cockerell (*3*) in 1899 as *Phoenicococcus marlatti*. Although this insect, now known as the red date scale, was considered in connection with the parlatoria date scale, it was not regarded as a major pest, and no serious attempt was made to eradicate it. Forbes (*5*) compares the two scales as follows: "*Parlatoria blanchardi*, when once established, spreads rapidly, damages the foliage of the date palm, and renders the fruit unmarketable, being therefore a serious menace to the industrial future of the tree under our climatic and cultural conditions. * * * *Phoenicococcus marlatti*, because of its closer confinement to the bole of the palm, is comparatively harmless and to be regarded with less apprehension."

EARLY CONTROL EFFORTS

Immediately after the parlatoria scale was found in Washington, steps were taken to clean up the palms before sending them on to their destination. The scale proved to be difficult to eradicate but was thought to have been eliminated by repeated applications of a strong kerosene and soap emulsion and the offshoots were then released (*14*).

Two years later, however, two of the nine palms on the University of Arizona farm were found to be heavily infested with this scale. Repeated applications of kerosene emulsion failed to eradicate it and other sprays tried were equally ineffective, as were repeated cyanide fumigations. In 1903 the scale was found to be spreading to neighboring seedling palms. In 1905 it was found not only on the palms of the university farm and on adjoining seedling plantings but also on palms in the Tempe cooperative garden and on other imported palms at Yuma and in California, in spite of the cyanide fumigations that were made.

The red date scale was found to have survived these early treatments.

It seemed evident that unless some more effective method of treatment were devised eradication of the parlatoria date scale would be impossible and even control would be difficult. R. H. Forbes, director of the Arizona Agricultural Experiment Station, assisted by A. J. Shamblin, began a study of the problem in 1905.

The persistence of the scale was found to be due to the structure of the date palm. This palm is endogenous, with an unbranched cylindrical trunk having a single growth bud well protected in the cone-shaped top. The leaves are pushed up, in groups of three, through the tip of the cone by basal growth in the bud, with the leaflets, or pinnae, at first tightly folded against the midrib but unfolding as the leaf approaches full size. Each leaf as it emerges has a triple-layered sheath which encircles the growth center and is attached to the trunk at the base of the petiole. This sheath is at first white and succulent but later becomes brown, tough, and fibrous. The pinnate leaves when full grown are from 10 to 20 feet long. The pinnae are arranged along a midrib, which is 1 or 2 inches in diameter at the base of the blade. The petiole from the base of the blade to the fiber line, commonly referred to as the spine area, widens gradually and that part of the petiole under the fiber, the leaf base, widens increasingly to its point of attachment to the trunk. The leaf bases are about 2 inches thick and 10 inches wide at their greatest diameter. The leaves are attached to the trunk in whorls by tough fiber bands, and the closely imbricated leaf bases with the protecting sheaths, or the fiber bands, form a thick trunk covering which persists after the leaf blades are removed. During the growth of the leaf a bud is developed at the inner base which may develop into an offshoot or a fruit stalk, or may die. The offshoots ordinarily develop at the base of the trunk but may develop at any height on the trunk. There is trunk growth at the apical cone; that is, increase in diameter to the size of the trunk below and an annual increase in height of about 18 inches or more, depending on the condition and variety of the palm. The fibrovascular bundles are also branched in the growth area to supply the new leaves, fruit stalk, and offshoots with sap.

Careful inspection of the old infested palms on the experimental farm near Phoenix showed that the old leaf bases below the fiber were still alive and succulent, even those 12 years old and near the bases of the palms. Living scale was found on these leaf bases, evidently protected from the sprays and gas. In the Tempe garden the scale had persisted on the lower leaf bases of some of the palms and had not been evident until offshoots had developed near the infested bases.

A method of treatment was devised by Professor Forbes which consisted in removing all the leaves from the palm, except the terminal leaves growing from the bud, which were cropped short, and cutting back the leaf bases close to the trunk. The flame of a gasoline torch was then run over the exposed surface. By this method the palms on the experimental farm were freed from the parlatoria date scale and all other known infested palms in the Salt River Valley were treated and work was then begun in the Tempe garden (*5*).

DEVELOPMENT OF ERADICATION PROGRAM

The appropriation bill of the Arizona Agricultural Experiment Station passed by the Territorial legislature of Arizona in March 1907 included a proviso authorizing the station officials to inspect for insect pests, especially *Parlatoria blanchardi* and *Phoenicococcus marlatti*, date palms growing in Arizona and shipments of offshoots brought into the Territory and to treat or destroy infested palms or offshoots.

In 1909 an act was passed by the Territorial legislature for the creation of a horticultural commission. This act authorized the commission to make regulations governing the entry of plants and plant products into the Territory, to provide for inspection and pest control, and to hire an entomologist and assistants to enforce the regulations. The commission was appointed and the entomologist's office organized in 1909. The second annual report of the commission (*6*) states that date palm scales "have been controlled by the agricultural experiment station with such satisfactory results that they may be considered rare insects in Arizona at present." Although the experiment station was specifically authorized by the Territorial legislature to carry on control work against the date scales, the commission evidently cooperated with the station officials. The following item is quoted from the fourth annual report of the commission (*7*): "Three lots of date palms have been discovered during the past fiscal year to be infested by the date palm scale (*Parlatoria blanchardi*) and have been treated by Inspector Acuff, of district No. 2, in accordance with the method of treatment devised by the agricultural experiment station." On January 21, 1913, a quarantine order was adopted by the commission regulating the admission of date palms into the State and their transportation within the State.

A Federal Notice of Quarantine (No. 6) on account of the parlatoria date scale and the red date scale (*15*) became effective on March 24, 1913, under the Plant Quarantine Act, which was approved on August 20, 1912. Under this quarantine the areas in which these scales were known to occur (fig. 3) were defined and Regulations were made for the interstate movement of date palms and offshoots from these areas. The State entomologist of Arizona was appointed collaborator on March 6, 1913, in connection with the enforcement of this quarantine.

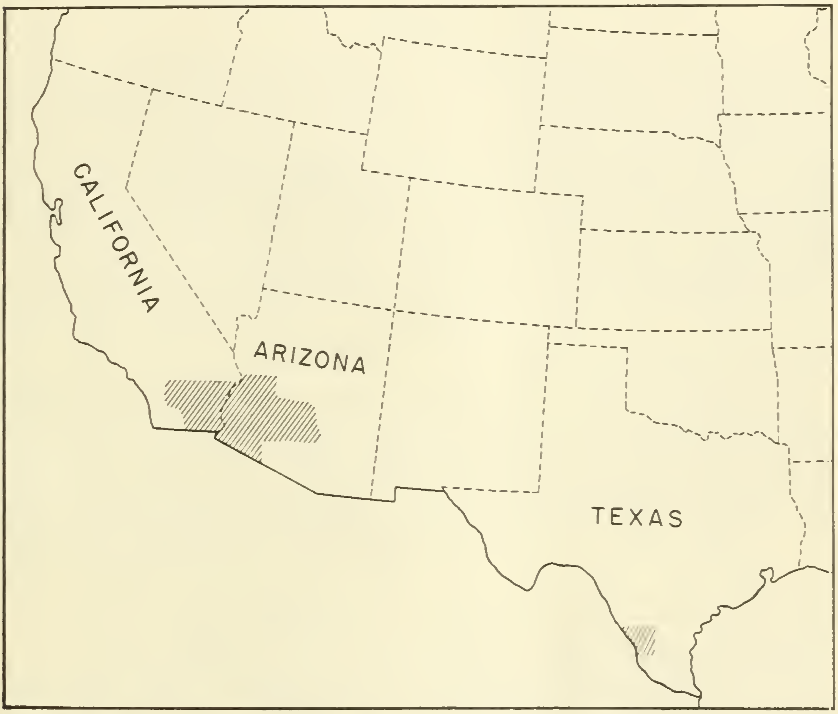

FIGURE 3.—Areas infested with the parlatoria date scale and the red date scale as defined by Federal Quarantine No. 6. Cross-hatching indicates regulated areas.

In view of the progress made in Arizona, a program was initiated for the extermination of the parlatoria date scale in all known infested areas. In 1914 the Federal Horticultural Board appointed Mr. Shamblin, who had been associated with Professor Forbes in the early work on the scale, to cooperate with the other agencies interested and coordinate the eradication work in the various localities. Headquarters were established at Mecca, in the Coachella Valley, and a vigorous campaign was begun using cyanide fumigation under metal containers for offshoots or newly set palms and the torching method, more or less modified, for the larger palms and deep-seated infestations.

In 1915 the California Legislature passed a law regulating the movement of date palms and date palm offshoots, the law to be enforced under the supervision of the State commission of horticulture.

PROGRESS IN ERADICATION, 1914 TO 1927, INCLUSIVE

Arizona

In 1914 the originally infested property, the experimental farm at Phoenix, was free from the parlatoria date scale, but scale was still being found in the Tempe garden and in an experimental planting that had been established at Sacaton, about 25 miles south of Tempe, with offshoots from the experimental plantings at Indio and Tempe. Scale was also found on palms in the Yuma experimental garden and in the city of Yuma and vicinity. A 1913 shipment from Africa via the Coachella Valley that was held in quarantine at Yuma was planted near Yuma and no scale was found in the planting after 1915. The planting became the Cook nursery, and many gardens in the Coachella Valley were established with palms and offshoots from this planting.

Eradication work was continued under the new program and progress seemed to be satisfactory until 1919 and 1920, when severe outbreaks of the scale occurred in the Tempe and Yuma experimental gardens and hundreds of seedling date palms (ornamentals) in the city of Yuma were found infested, a result no doubt of spread from the infested imported palms by movement of offshoots and other means. There was also evidence of spread in the Salt River Valley near Phoenix. The Tempe and Yuma experimental gardens were defoliated and torched, and many of the infested palms in the city of Yuma were dug out and destroyed and the remainder torched.

The Arizona Commission of Agriculture and Horticulture strengthened its regulations concerning the movement of date palms and date palm offshoots within the State and assigned an inspector to enforce the regulations and to carry on systematic inspection in cooperation with the Federal Horticultural Board and the Arizona Experiment Station.

In the Tempe garden and surrounding territory only 2 infested palms were found in 1923, and none were found in 1924, 1925, and 1926. In Yuma and vicinity a total of 354 infested palms were reported in 1923 and 86 in 1924, 2 of them being in the experimental garden. In 1925 and 1926 no scale was found in the experimental garden, but 91 and 75 infested palms were reported in the city of Yuma. In 1927 no infested palms were reported in the experimental garden and only 5 in Yuma. In the Salt River Valley, however, where no scale had been found for 3 years, 59 infested palms were found in 8 dooryard plantings.

TEXAS

A cooperative date planting that had been made near Laredo, Tex., about 1906, with offshoots from the experimental gardens in Indio and Arizona, was inspected in 1915 and found to be heavily infested with the parlatoria date scale. Treatment was begun immediately and by 1919 the planting was apparently free from scale. When the planting was carefully inspected in 1924, no scale was found and there was no evidence of spread to nearby seedling date palms.

CALIFORNIA, IMPERIAL VALLEY

Sometime prior to 1914 a commercial planting of imported offshoots was made by the California Date Corporation near Heber. These offshoots were infested with the parlatoria date scale, and the scale spread to a planting of several hundred seedling palms on the same property. The imported palms and some of the seedlings were purchased by D. B. Holmes and moved to his property at Indio in 1916 and 1917. The remaining seedlings were destroyed or treated.

Two commercial plantings of imported offshoots were made near El Centro in 1915, approximately 350 palms in each planting. These gardens were infested, and an attempt was made by the owners to control the scale. It was not until 1923 that systematic inspection and treatment looking toward eradication was begun. All palms in these plantings were infested in 1923 and treated. Each succeeding year showed improvement in the situation until in 1927 only 2 infested palms, 1 in each garden, were found.

In 1923 a seedling planting of approximately 2,500 palms was found generally infested. All but 23 of these palms were destroyed and those remaining were treated. Seven hundred offshoots from these palms which had been planted on another property were also destroyed. Also 178 heavily infested seedlings in 7 dooryard plantings were found and destroyed. During the years 1924–27, 100, 155, 25, and 26 infested dooryard seedling palms on 15 properties were found infested and destroyed or treated.

CALIFORNIA, COACHELLA VALLEY

When the eradication work was begun in the Coachella Valley in 1914, there were 3 established date gardens, 2 experimental, at Indio and at Mecca, and 1 commercial, at Mecca, with a total of approximately 1,500 palms, which had been imported from 1903 to 1908. Each garden was infested.

There were also approximately 20,000 offshoots in the valley which had been imported for commercial purposes from 1911 to 1913 and which were being held in nurseries. In 1914 and 1915 additional commercial shipments totaling about 9,000 offshoots were imported. Shamblin (*9*) states that approximately 55 percent of the offshoots imported up to and including 1915 were infested with the parlatoria scale. From 1908 to 1914 hundreds of thousands of date seeds were planted in the valley, with the idea of establishing date gardens by selection of the most promising palms.

Eradication work was begun in the nurseries and propagation houses and in the field plantings. Owing to the growers' lack of experience in date culture, over 75 percent of the imported offshoots died before becoming established in the field. Most of the remainder were free from scale when planted on the various farms, although the scale persisted on some in the field.

In 1920, 35 plantings made with imported offshoots were free from scale. Scale persisted, however, in the 3 originally infested gardens and 8 additional plantings. There were approximately 5,700 imported palms on these properties, some being in nursery, and a total of 837 were reported infested during the year. Previous to 1920 there had been evidence of spread of the scale to seedling palms on infested premises; and in 1920, 2 plantings previously considered clean were found infested. One was a seedling planting of approximately 1,000 palms, which was heavily infested, although the number of infested palms was not recorded, and the other was a planting of 87 standard palms, 2 of which were lightly infested.

In 1921 no new infestations were discovered, but scale was still being found in the 11 plantings found infested prior to 1920, 848 infested palms being reported. No scale was observed in the 1920 infestations of standard palms, but the 1920 seedling infestation continued to show scale. A shipment of 1,456 offshoots was received from Algeria during 1921 and set in the field near Indio. These offshoots were reported to be 100-percent infested.

In 1922 no scale was found in one of the plantings infested prior to 1920 and only 242 infested palms were found in the remaining properties of this group. This reduction from the 848 infested palms in 1921 indicated that progress was being made. One hundred and seventy-three infested palms were observed in the 1920 seedling infestation and 1,338 in the 1921 imports. In addition, 24 infested palms were found in 3 standard plantings having a total of 268 palms which were previously considered clean.

In 1923 no new infestations were located and only 170 infested palms were found on 13 properties, as compared with 1,777 on 15 properties in 1922. One of the previously infested properties on which no scale was found was evidently clean, but one infested palm was found on the other in 1924.

In 1924, 6 of the 11 properties infested prior to 1920 and 3 of the 5 found infested in 1920 and 1922 continued to show scale, 115 infested palms being located on these 9 properties. Also 151 infested palms were reported in the 1921 imports. Nine new infested properties were found during 1924. One of these was a neglected planting in the Arabia district of approximately 350 seedling palms, all infested. Some of the palms were white with scale. Six of the remaining new infestations were within a radius of 1½ miles of the heavy infestation. There were approximately 3,000 seedling and 1,054 standard palms on these 7 properties, of which 601 were reported as infested. The 2 remaining new infestations were in the town of Coachella and in an experimental planting on the Martinez Indian Reservation. The ornamental date palms in Coachella were generally infested, 162 infested palms being recorded during the year. Two infested palms were found in the Martinez experimental planting.

In 1925 the situation as far as the older infestations were concerned was improved. Only 96 infested palms were found on 7 of the 17 properties on which scale had been found from 1920 to 1923, inclusive. Ten of the seventeen seemed to have been definitely freed from scale. Approximately 225 infested palms were found in the 9 properties infested in 1924, however, and 112 on 8 new infested properties in 1925. Seven of these new infested properties were within a radius of 1½ miles from the town of Coachella. One of these was a planting of 145 standard palms and another 73 standards and 50 seedlings. The remaining 5 were seedling plantings, several thousand palms in all, some in gardens and others in jungle nurseries. The eighth new infested property was a seedling planting of 776 palms in the Arabia district, where only 1 lightly infested palm was found.

In 1926 conditions on the known infested properties improved as in 1925. Only 202 infested palms were found on 21 properties, 22 of the palms being on a property that was in all probability free from scale and reinfested. Seven infested palms were found on this property in 1921 and none from 1922 to 1925. Also 8 new infested properties were found in 1926. Six of these were seedling plantings, totaling approximately 7,500 palms, located in the Arabia and Coachella districts in the vicinity of heavy infestations. One was a planting of 339 standard offshoots from an infested garden, 21 of them being infested. The other was a property on which there was a small group of standard palms and a neglected seedling planting. This property was outside what had been considered the infested area. Eleven standard offshoots had been moved there from an infested garden. Scale developed on the offshoots and spread to the seedlings. Sixty-four infested palms were recorded on the new infested properties.

In 1927, as in previous years, there was a decided improvement in conditions on the known infested properties as a whole. Only 42 infested palms were found on 11 of the 42 properties that had shown scale at some time during the period 1920–26. Eleven of the infested palms, however, were found in a planting of 850 standard palms heavily infested in 1920 but which had shown no scale during 6 inspections over a period of 11 months. Also 12 new infested properties were found during the year. Seven of these were in the Indio district, where very little scale had been found for several years. One was a planting of 27 seedling palms white with scale. In the town of Indio 6 ornamental seedling palms were found infested. In the Mericos garden, a planting of 4,543 standard palms, 389 infested palms were found. Several seedling palms moved from this garden to 2 nearby commercial plantings were infested. Two additional infested commercial plantings, 1 of 374 standards and 190 seedlings and the other of 97 standards and 302 seedlings, were located in the Indio district. One infested ornamental palm, a Mericos seedling, was found in the town of Palm Springs. A commercial garden of 280 standard and 950 seedling palms, 2 abandoned seedling plantings of 300 and 4,358 palms, and a dooryard planting of 32 palms, also infested, were located in other parts of the Coachella Valley.

The progress made in eradication work in the Coachella Valley during the years 1920–27 is shown in table 1.

TABLE 1.—*Annual status of eradication in the Coachella Valley from 1920 to 1927*

Year	Total infested properties	New infested properties	Infested palms
	Number	*Number*	*Number*
1920	13	2	[1] 839
1921	13	1	[1] 2,304
1922	15	3	1,777
1923	13	0	170
1924	19	9	1,031
1925	24	8	433
1926	29	8	266
1927	23	12	893

[1] Total does not include a number of seedlings found infested in a planting of about 1,000 palms.

SITUATION IN THE DATE-GROWING AREA AT THE CLOSE OF 1927

The infestations found during 1927 caused much concern to both growers and agricultural officials. In the Coachella Valley the properties infested in 1920 had shown continued improvement from year to year and the new infestations found up to 1927 were largely seedling plantings of little value and in an area so far removed from most of the valuable commercial plantings that the latter seemed in little danger of becoming infested. The apparent reinfestation of 2 commercial gardens that had been considered clean; the finding of heavy infestations outside what had been considered the infested area, endangering districts that were apparently free of scale; and the finding of 389 infested palms in the largest planting of standard palms in the valley, the Mericos garden, which had been considered free from scale, changed the aspect of the situation.

In the Salt River Valley also, where there had been renewed interest in date growing during the past few years and no scale had been found for 3 years, the finding of 59 infested palms in dooryard plantings was very disturbing.

To meet the emergency an item of $25,000 was included in the deficiency bill of December 1927 to supplement the regular amount included in the Federal Horticultural Board appropriation for date scale eradication. It was decided to conduct a survey of the entire date-growing area in the Southwest to determine the extent of the date plantings and the situation in regard to parlatoria date scale infestation; also to review the past work and determine whether or not eradication of the scale seemed feasible under the existing conditions.

SURVEY OF THE DATE-GROWING AREA

With the additional funds available the date scale inspection force was increased and a systematic survey of the date-growing area was begun. The main objectives were to determine the number of palms and locate severe infestations so that a better idea of the extent of the problem would be obtained.

For each planting located a report was submitted giving the following data: Owner, locality (township, range, and section), number of palms, seedling or standard variety, age of palms (1 to 4, 5 to 9, or 10 years or over), type of planting (dooryard, garden, abandoned, or seedling jungle), and information as to the ease or difficulty of inspection. As the reports were turned in the plantings were located on wall maps with numbered tacks, the numbers corresponding to those on typed lists of properties. The color of the tack indicated whether a property was infested; and if infested, the year was given. Each report was filed with all previous notes on the property, and a 5- by 8-inch card was prepared giving a summary of the history of the planting with the dates of all inspections, the number of palms found infested on each inspection, and the treatment of infested palms.

The survey of the Coachella Valley was begun in January 1928 and completed in June, and 136,756 date palms ranging in height from 5 to 50 feet and over were located, nearly all in an area of approximately 120 square miles extending from about 4½ miles southeast of Mecca to 2½ miles northwest of Indio. One thousand two hundred and twenty-nine of the palms were on lots or along streets in the towns of Indio, Palm Springs, Thermal, and Coachella, and the remainder on 479 properties in various localities in the valley.

Of the palms listed 55,277 were standard varieties; 34,184 being from 1 to 4 years old; 11,570 from 5 to 9 years old; and 9,523, 10 years old or older. The remainder, 81,479, were seedlings, 6,164 from 1 to 4 years old; 15,634 from 5 to 9 years old; and 59,681, 10 years old or older. The ages of the standard palms as listed were fairly accurate, for records had been kept of the plantings. The seedlings, however, were classified more according to size.

Most of the standard palms were in well-kept gardens ranging in size from a few palms to nearly 5,000. Comparatively few of the seedlings were receiving good care, and most of these were in commercial gardens with standard palms. Only a very small number of seedling plantings could be classed as producing commercial gardens. A few were dooryard plantings, which produced good fruit for home consumption. There were some partly thinned seedling plantings that the owners hoped to develop, but most of the seedlings were in abandoned plantings that were kept alive and growing by waste irrigation or underground water. Most of the abandoned plantings were overgrown with mesquite and other desert plants. Fifteen abandoned seedling plantings of 1,000 to 5,000 palms and 26 of 100 to 1,000 palms were listed in the survey, as well as 14 plantings of 100 to 2,000 palms that were neglected but receiving some care from the owners. The remainder of the seedling palms not in commercial gardens were single palms or in groups up to 100. In most cases the numbers of palms in the seedling plantings were estimated, for it was impossible to make accurate counts of unthinned plantings or plantings badly overgrow with brush.

Two heavily infested neglected seedling plantings and 1 lightly infested commercial garden were found during the survey. One of the seedling plantings was in the Mecca district and contained 1,484 palms, all of which were infested, and the other was in the Thermal district and contained about 200 palms, all but 2 of which were infested. Some of the seedlings were in a jungle too dense to count or inspect. The leaves on some of the palms were white with scale. The commercial garden was a planting of 24 standards and 106 seedlings, all small. Four palms were found infested.

Practically all the infested properties in the valley were within 2 miles of the railroad from Mecca through Arabia, Thermal, and Coachella to Indio, the strip approximately 16 miles long. In this strip were the gardens which were infested in 1914, the persistent infestations found from 1914 to 1920, and all except four of the infestations found during the period 1920–28. These four infestations were in two small seedling plantings in the West Side and Martinez districts, a small standard planting in the Martinez district, and an ornamental seedling planting in the town of Palm Springs, all of which resulted from the movement of offshoots from infested properties.

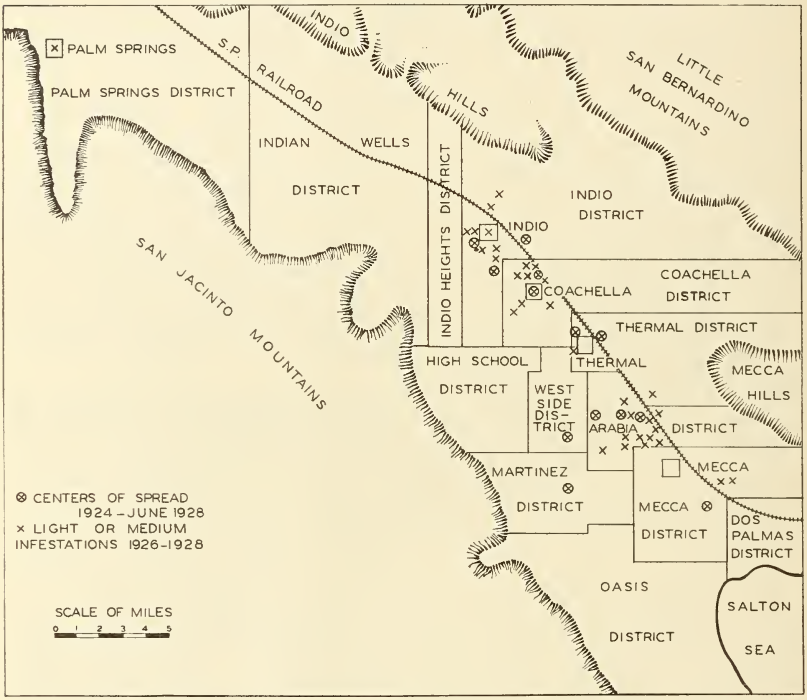

FIGURE 4.—Coachella Valley eradication area.

All territory within 2 miles of heavily infested plantings was designated as the infested area. The map indicated that the farthest spread not accounted for by the movement of infested offshoots was 1½ miles. An additional half mile was added for safety. There were 63,640 date palms in the infested area, approximately 19,000 standards and 44,500 seedlings. In the infested plantings there were 14,246 palms, well over half of them standards. Outside the infested area there were 73,116 date palms, about equally divided between seedlings and standards.

For convenience in inspection and clean-up work both the infested and outside areas were divided into districts, as shown in figure 4. All infestations heavy enough to be considered centers of spread found from January 1, 1924, to the completion of the survey in June 1928 are located on the map, as well as all properties on which scale was found during 1926–27 and in 1928. The separate infested properties in towns are not designated.

It seemed probable that the persistent work on the originally infested offshoots and plantings had been successful and that by 1928 all had been freed from scale. During the process, however, the scale had spread to many seedling plantings, where it had built up and was reinfesting previously infested properties as well as infesting properties that had never shown scale before. During the years 1924–28 numerous infested seedling plantings heavy enough to be considered centers of spread had been found from Mecca to Indio. Those found in 1927 were near the outer edge of the old infested area and showed an outward spread from the old infestations.

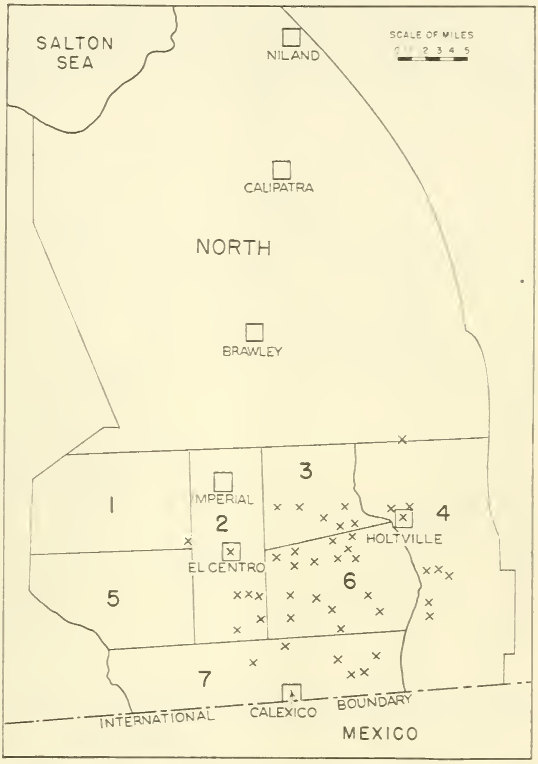

FIGURE 5.—Imperial Valley eradication area. Numbers refer to inspection districts and crosses show location of infestations.

The survey of the Imperial Valley was begun in May 1928 and completed in December of that year. A total of 33,044 date palms were located in an area of approximately 500 square miles. Approximately 2,000 of these palms were of standard varieties.

Infested palms were found in various localities in the southern part of the valley, and this area, about 300 square miles in extent, was designated as the infested area. It was divided into 7 districts, exclusive of the towns of Calexico, Imperial, Holtville, and El Centro, which were handled as individual units (fig. 5). There were 14,466 palms on 770 properties in the 7 districts and 2,390 palms on 611 properties in the 4 towns. These included 19 plantings of 100 to 1,000 palms each and 1 seedling planting of 2,876 palms. The remainder of the plantings in this area had less than 100 palms to a property.

In the southern part of the valley scale was found on 32 properties, a total of 1,077 infested palms being recorded. Eight of these properties were old infestations, but the remaining 24 had not previously been recorded. No scale was found in the northern part of the valley, although 16,188 palms were located.

In 1928 the two standard plantings established in 1915 remained and there were a few small plantings of standard palms. Most of the palms in the latter plantings were young. There were, however, a large number of seedling palms. Many of these seedling palms were in dooryard plantings and were classed as ornamentals, although some were producing edible fruit. Others were abandoned palms along irrigation ditch banks and property lines, and still others were in large seedling plantings, which were mostly unthinned and abandoned except for a few in orchard form that were receiving care.

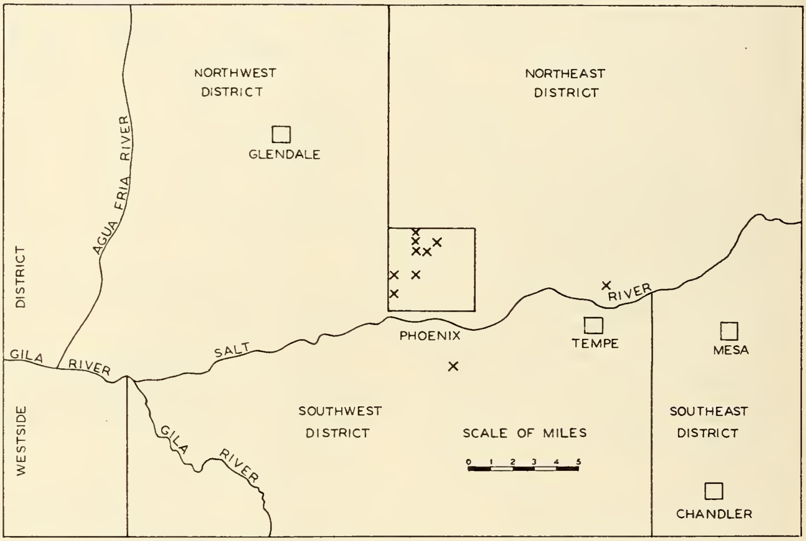

Figure 6.—Salt River Valley eradication area. Crosses show location of infestations.

The scale had been introduced on the standard palms and had spread to seedling palms by natural means or by means of the movement of offshoots. Comparatively little eradication work had been done in the Imperial Valley outside the two old standard plantings. These plantings had been solidly infested when the work began and had been showing gradual improvement from year to year. In 1928 the two gardens were inspected twice and no scale was found in one, the Reed garden, and only one infested palm in the other, the Williams garden.

In the Salt River Valley the survey of 1928 was carried on in cooperation with the Arizona State entomologist's office. A total of 32,405 date palms were located, most of them in an area of approximately 162 square miles. This area was divided into districts, and an infested area of approximately 50 square miles including the city of Phoenix was designated. Of the palms located 7,562 were listed as standards and the remainder seedlings. Comparatively few large plantings were found. Only 3 plantings listed had over 1,000 palms, namely, a planting of 2,516 seedlings, a planting of 1,192 young standards, and a planting of 700 standards and 1,160 seedlings (fig. 6). Of the palms located in the valley, excluding the city of Phoenix, 25,699 were listed on 1,075 properties. Forty-six properties had more than 100 palms, 209 from 10 to 100 palms, and 820 less than 10 palms. In the city of Phoenix approximately 7,000 palms were located.

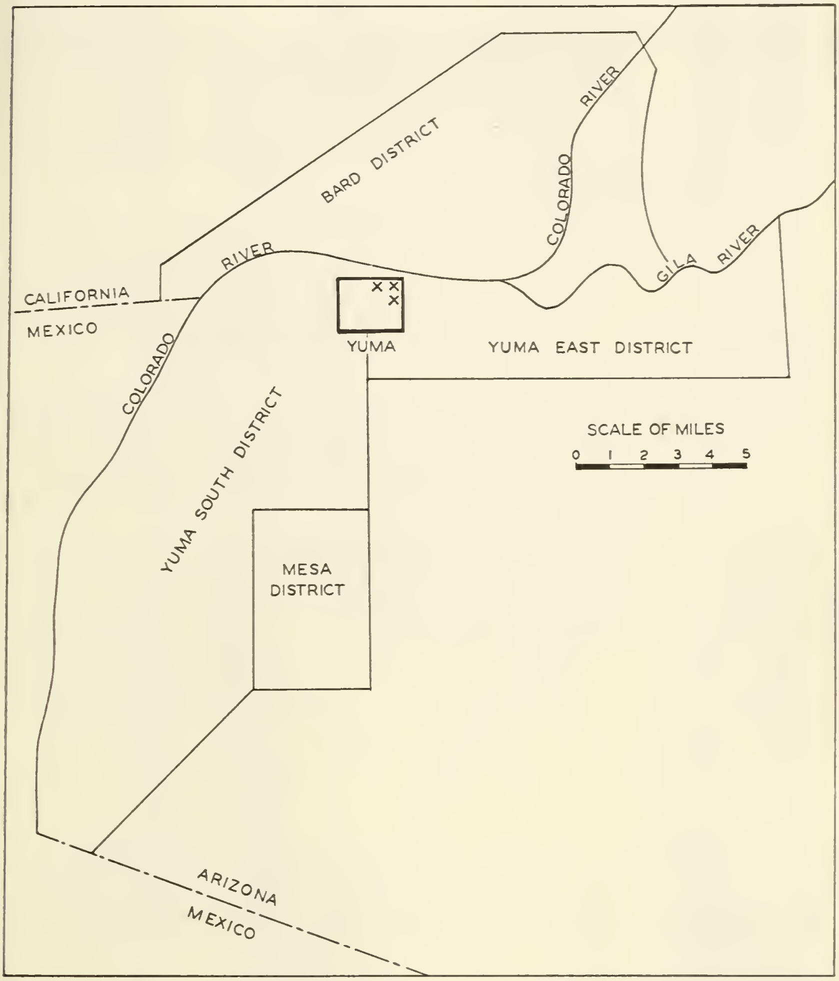

FIGURE 7.—Yuma Valley eradication area. Crosses show location of infestations.

Twenty-one infested palms were found on six properties, only one of the properties being a new infestation. The scale, introduced on the imported offshoots, had been eradicated in the original plantings, but the appearance of it on scattered seedlings showed that eradication had not been entirely accomplished.

Owing to the infestations in the city of Yuma, periodic inspections had been carried on in the city and on some of the larger plantings in the Yuma Valley (fig. 7), and considerable scouting had been done. The situation was, therefore, fairly well known, and no complete survey was made in 1928. The following information was taken from the inspection reports then available and supplemented by later surveys and inspections.

There were approximately 19,000 palms in the valley in 1928, most of which were in an area of 166 square miles. Included in this area was the city of Yuma, with approximately 1,700 palms. Of the total number 3,434 were standards. There were 2 large standard plantings of approximately 1,000 palms each and 5 of 100 to 400 palms each. There were 3 seedling plantings of 1,000 to 3,000 palms each and 13 of 100 to 800 palms, the remainder being of less than 100 palms.

The scale had been brought into the valley on imported offshoots and later spread to seedling palms. The ornamental seedlings in the city of Yuma had been generally infested. Persistent eradication work had gradually reduced the number of infested palms found each year until in 1928 only four infested palms were found in the valley, these on three properties in the city of Yuma.

A planting of standard palms at Laredo, Tex., which was infested when first planted, was inspected in August 1928 and no scale found. There were 19 of the original palms in the planting, together with 32 offshoots from the older palms and 30 seedlings. Inspection of seedling plantings in the immediate vicinity of the standard planting disclosed no scale.

A casual survey of the Rio Grande Valley from Laredo to Brownsville was made, and 9, 615 date palms were recorded. All these were seedlings except a planting of about 100 standard palms at the Weslaco Experiment Station. No parlatoria date scale was found.

According to the information available, the only infested palms brought into Texas were those in the planting at Laredo; and in view of the past history of the Laredo garden, there was little chance that the scale had spread to other plantings.

GENERAL INFORMATION ON THE SCALE

While the survey was in progress routine work in infested plantings was being carried on, and a study was made of the past records of the project. Little detailed work on the biology of the parlatoria scale had been done, but observations by Forbes (*5*), Cockerell (*4*), and Stickney,[3] together with the records kept of the eradication work in the Coachella Valley, gave a very good idea of the behavior of the insect in the field.

Description

The parlatoria date scale is an armored scale elongate oval in shape. The covering of the adult female is about one-twentieth of an inch long and one thirty-fifth of an inch wide and that of the male about one twenty-fifth of an inch long and one-sixtieth of an inch wide. The anatomy of the insect has been described in detail by Stickney (*10*).

---

[3] Unpublished manuscript on date insects.

On the plant the female appears as a dark speck surrounded by a white border. This dark appearance is due to the color of the molted skins, which range from light brown to almost black and are visible through the wax covering. The male scale (figs. 8 and 9) is white in appearance, since the molted skin is pale yellow and not visible through the covering.

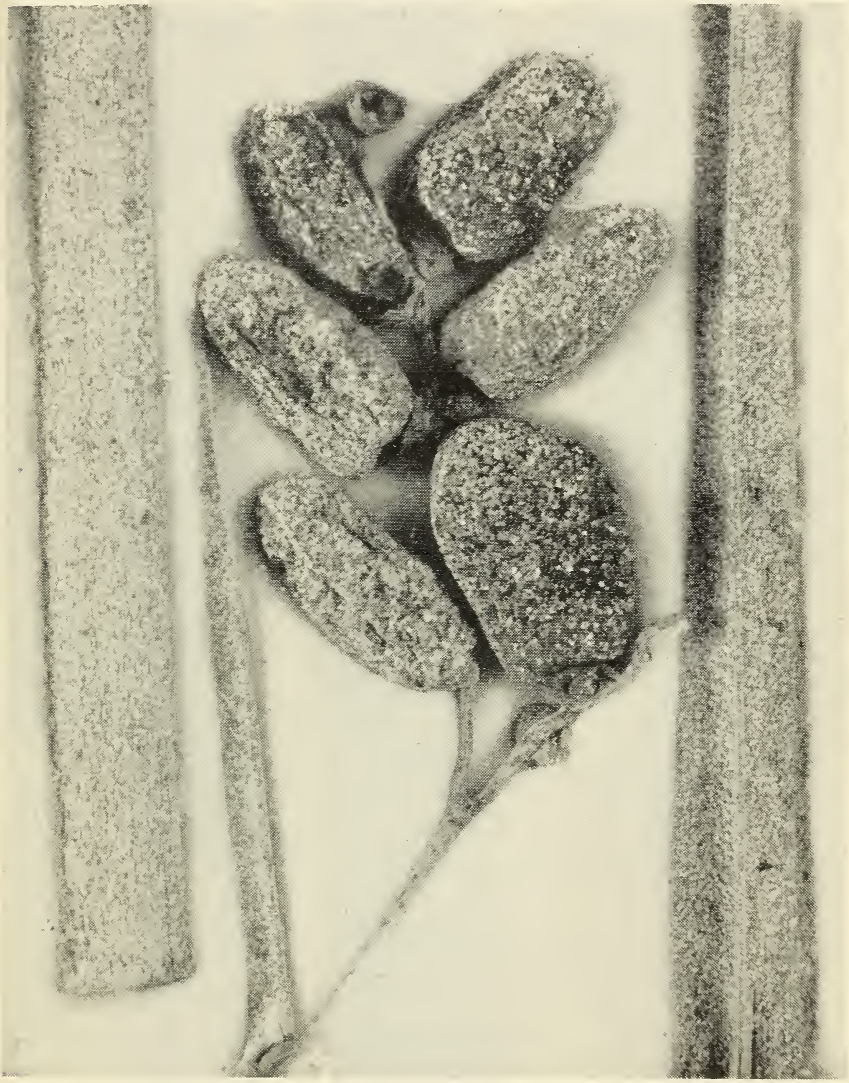

FIGURE 8.—Parlatoria date scale on pinna, fruit, spine, and fruit stem of date palm.

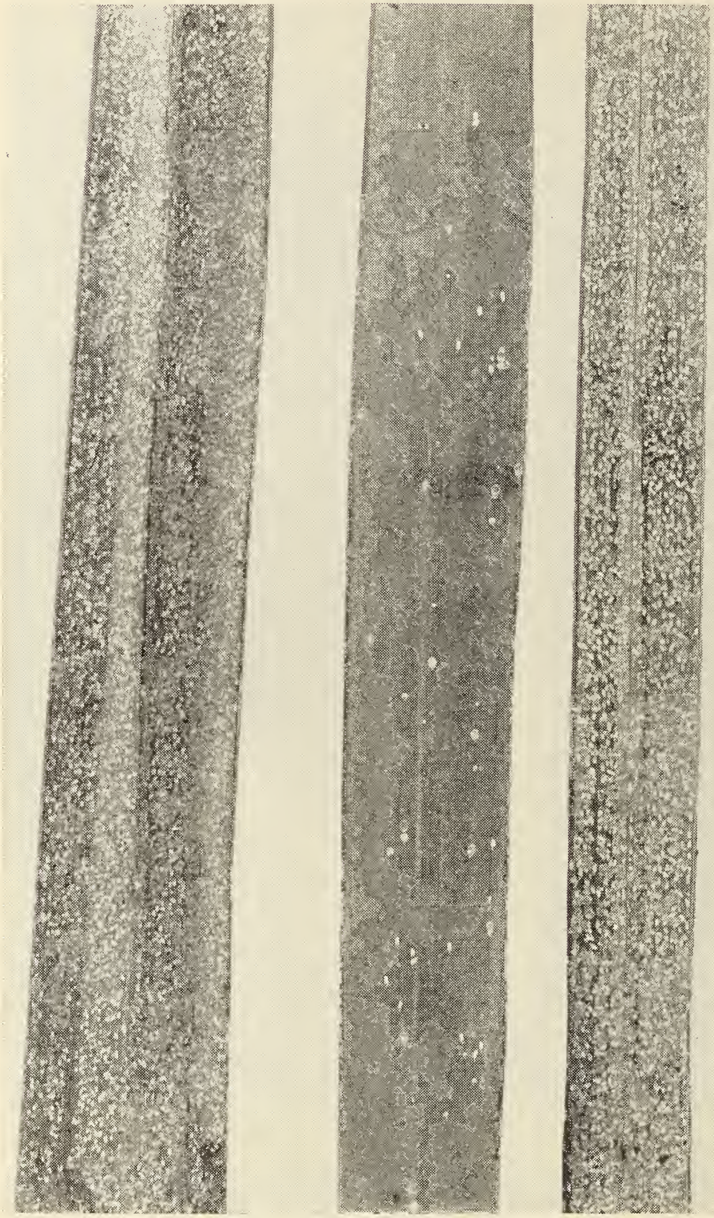

FIGURE 9.—Scale on date palm pinnae.

LIFE HISTORY

The insect is oviparous. The eggs are laid and hatch under the covering of the female. The newly hatched crawlers emerge from under the covering and settle in a very short time. Usually they settle in the immediate vicinity of the producing female and so thickly as to encrust the host material there, leaving surrounding parts of the palm only lightly or moderately infested. These encrustations are conspicuous on the green foliage and were indicated on inspectors' reports as "white leaves." The female scale is motile only in the crawler stage, but the male is also motile as an adult. Stickney (*10*) states that in a lot of 186 males examined 56 percent had fully developed wings, 19 percent had wings in various degrees of development, and 25 percent were wingless.

Field observations by Stickney[4] and inspection reports indicated that there are no regular broods but an almost continuous production of crawlers throughout the year, probably slowing up during the the cold periods in the winter.

PARASITES

Although the scale is presumably controlled in most localities in the Old World by parasites, no introduced natural enemies have been recorded in this country. Native coccinelids have been observed feeding on the insect but did not noticeably affect the population increase.

ECONOMIC STATUS

The scale infests all exposed portions of the palm and also in heavy infestations reaches the leaf bases beneath the bands of fiber. Heavy infestations on leaves obviously interfere with their functions, and in many instances leaves are killed outright by the insects. The fruit is rendered unsightly by the attacks of the scale.

Whether or not the scale if unchecked would ultimately kill an established and growing date palm under the conditions in the date-growing areas of the Southwest is not known. Judging from the vigorous growth of the palm, its reaction to complete defoliation, and its endogenous character, such a result seems doubtful. The prolific production of crown leaves would probably provide sufficient uninfested surface to keep the palm alive.

From the observations over a period of more than 30 years, however, it seemed obvious that the production of marketable fruit in the Southwest would not be possible if the scale were not controlled.

HOST PLANTS

The parlatoria date scale has been taken only on palms, namely, the date palm (*Phoenix dactylifera* L.), the doum palm (*Hyphaene thebaica* Mart.), the Canary Island palm (*P. canariensis* Hort. *ex* Chabaud), and the native California fan palm (*Washingtonia filifera* (Linden) Wendl.).

---

[4] See footnote 3.

Scale was observed on doum palms only at the United States Department of Agriculture date garden at Indio, but these palms were not found elsewhere.

Canary Island palms are used extensively as ornamentals in the Salt River Valley and the Imperial Valley. The scale seemed to thrive on the foliage of this palm, and it was considered to be equal in most respects to the date palm in importance as a host of the scale. The leaf bases of the Canary Island palm are less succulent than those of the date palm, however, and therefore the danger of leaf-base infestation persisting after the palm had been freed from scale on the exposed parts was considered slight (fig. 10).

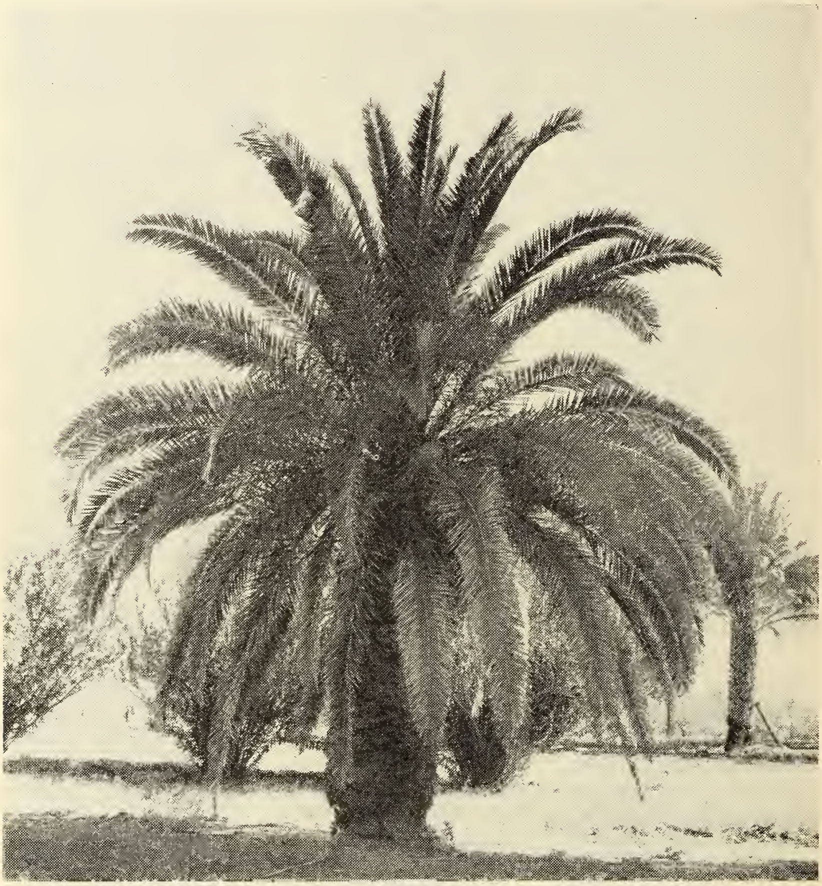

FIGURE 10.—Canary Island palm.

Instances were recorded of fan palms being lightly or moderately infested, but only in places where these palms were near heavily infested date palms. It was assumed that the infestations on the fan palms would die out if it were not for a continual supply of crawlers from the adjacent infested date palms. Further observations bore out this assumption as far as large fan palms were concerned.

In one case in the Imperial Valley a heavily infested date palm was dug out and destroyed on October 1, 1928. There were four large fan palms about 300 feet from the date palm which were not inspected or treated. On February 24, 1932, during fan palm inspection these palms were reported infested. They were defoliated and sprayed with heavy oil. As the leaves were cut they were carefully inspected for scale. The fan palm, like the date palm, grows from the terminal bud, new leaves being thrust from the bud continually during the growing season. The older leaves die but remain attached to the trunk of the palm. The life of a leaf is approximately 2 years, or perhaps less on older palms.

The following notes are taken from the report of treatment: "Palm 1 is south palm in row: There were 8 rounds of dead leaves on this palm, 21 dead leaves, and 3 green leaves found infested. The heaviest infestation on this palm was on dead leaves near the bottom rounds of dead leaves and fading out as we worked up to the green leaves. Heaviest infestation on east side of palm. Scale found on lower rounds of green leaves only. Palm 2 from south: The fan part of the leaves on all dead leaves and some of the lower green leaves had been cut off in the past. This is the smallest of the four palms. Scale was found on 3 dead midribs and on 2 green midribs; on 1 green midrib, scale extending down to within 1 foot of fiber. Palm 3 from south: 27 dead leaves found infested with scale. These leaves were lightly infested, beginning near the bottom rounds of dead leaves and fading out as we worked up to the green leaves. No scale found on green leaves. Palm 4 from south: 25 dead leaves found infested. Some of these leaves were quite heavily infested for fan palms. No scale found on green leaves on this palm. I examined some of the scale on the green leaves on palm 1, and they were full, juicy, and alive" (fig. 11).

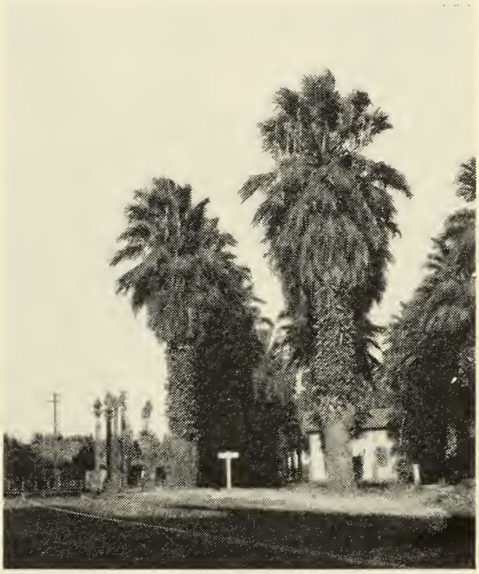

FIGURE 11.—Fan palms from which leaves and leaf bases have been removed at the base and dead leaves only for a considerable distance above. Several rounds of dead leaves and the growing crown leaves are shown at the top.

Many heavily infested young fan palms were found during the course of the work. The scale apparently grew and built up rapidly on these. In several cases where large fan and date palms were growing in groups the date palms were found to be infested and were dug out and destroyed. Two or three years later when the properties were checked the large fan palms were free of scale, but small fan palms near the large ones were heavily infested (figs. 12 and 13). In all probability these palms were very small when the infested date palms were dug out, the scale persisting on them and increasing as they grew. The chance that they had become infested from sources outside the property on which they were growing was negligible.

The new foliage of the native fan palm apparently is a very satisfactory host of the parlatoria date scale. The new leaves of a mature palm seem to harden rapidly, however, making it increasingly difficult for the crawlers to settle. This hardening of the leaves, together with the tendency of the crawlers to settle near the producing females, causes the palm to "grow away" from an infestation. A possible explanation of the fact that the scale seemed to persist longer on the young fan palms is that the leaves of a young palm growing from seed may live and stay succulent longer during the period when the root system and trunk are being developed.

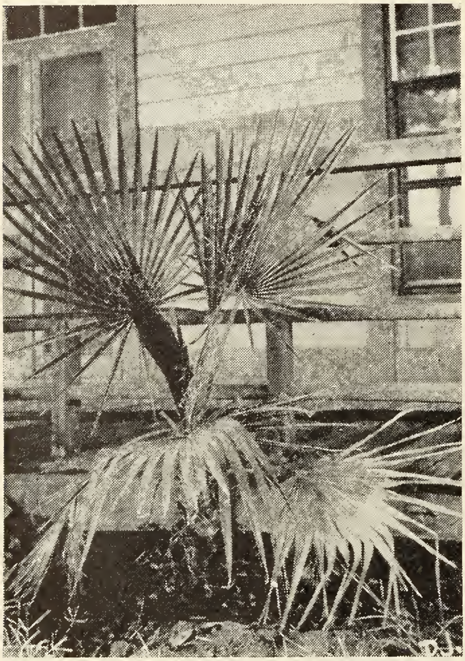

Figure 12.—Young fan palm infested with scale.

As the parlatoria date scale had been taken in the United States on no plants other than palms during the period 1890–1928, it seemed fairly safe to assume that no other hosts were of common occurrence in the infested areas. During the remainder of the eradication campaign, however, considerable inspection of plants other than palms was carried on in the immediate vicinity of infested date palms. The scale was found on no other plants.

Dissemination

Because the female parlatoria scale is wingless and motile only in the brief crawler stage, spread of the insect by its own activity is decidedly limited. The progeny of a few scales established on a palm would eventually cover the palm; but the spread would be comparatively slow, owing to the tendency of the crawlers to settle very close to the producing female. The spread from palm to palm would be negligible unless the palms were so close together that the foliage would intermingle.

The scale did spread, however, from palm to palm, from planting to planting, and even from continent to continent. The most obvious and effective means of spread was by the movement of offshoots for propagation purposes.

Other activities of man, such as pollinating and picking fruit, in which the worker moved from palm to palm, were thought by many to be a means of distributing the scale. Pollinating especially was thought to be a likely cause of spread, for the common procedure was to cut a sprig of bloom from a male palm and tie it in the female bloom. Both the male and female blooms develop within spathes, and pollinating is done shortly after the spathes open. The chance of the portion of the male blossom taken being infested with established scale seemed slight. The danger then of man's cultural activities would be of carrying crawlers on his clothing, sprigs of bloom, or tools from infested palms to noninfested palms. This manner of dissemination would apply mostly to the spread within gardens. There were instances, however, of growers obtaining male bloom from infested seedling plantings at some distance from their own gardens. Unfolded crown leaves used in certain religious ceremonies were sometimes cut from abandoned plantings. Evidence of this work was found in one heavily infested planting. This seemed a possibility of spread for considerable distances, as the same workers might cut leaves in different plantings on the same day.

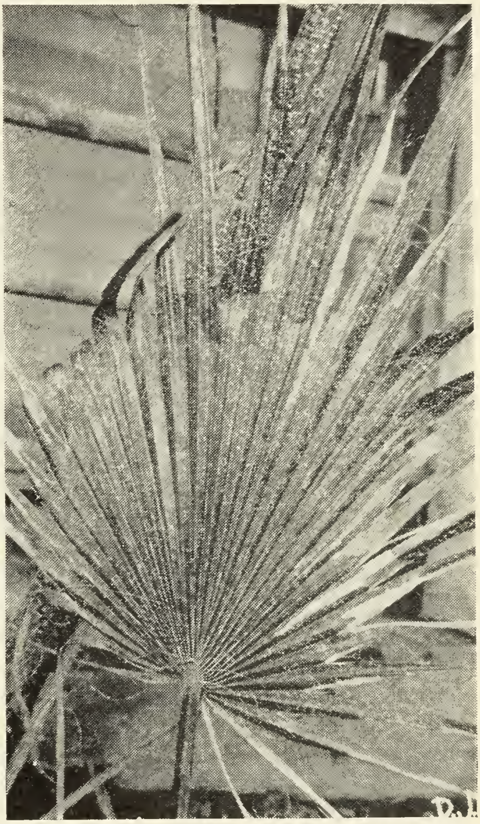
FIGURE 13.—Leaf of young fan palm infested with scale.

Cockerell (*4*) mentions the probability of the crawlers being carried by birds, winged insects, and ants, and also of being blown short distances by the wind. In inspection reports references were found to colonies of scale on date palms near birds' nests and around egg punctures of cicadas. Quayle (*8*) demonstrated that crawlers of the black scale (*Saissetia oleae* (Bern.)) were carried by the wind for a distance of 450 feet and expressed the opinion that the wind was a more important factor in the spread of scale insects than other insects, birds, and man.

The map of the Coachella Valley showing all date plantings located in the survey of 1928, together with eradication notes and maps of infested gardens covering the work from 1914 to 1928, indicated two types of spread, one by transportation of the scale in all stages on its hosts, the other by transportation in the crawler stage by the wind, and by man, birds, insects, or other animals moving from palm to palm. The wind seemed to be the most important agency carrying the scale in the crawler stage. There was no evidence that the scale had been transported over 2 miles except on date palms or date palm offshoots. There was considerable evidence that crawlers had been carried for approximately 1½ miles and had become established. Spread by crawlers was in general concentrically from heavy infestations, although the trend seemed to be from the southeast toward the northwest. Infested palms were most numerous in the immediate vicinity of heavy infestations and diminished in number and intensity of infestation as the distance from the heavy infestation increased. The height of the heavily infested palms and their location in regard to buildings, trees, and other vegetation, as well as other factors, seemed to influence the degree of spread.

REVIEW OF FORMER ERADICATION METHODS

Since the parlatoria date scale was introduced on the imported palms, eradication naturally centered on these. When the work was organized in 1914, the imported palms in the field were inspected frequently and those found infested were treated. The offshoots being held in nurseries and propagating houses were also inspected frequently and treated when necessary. All offshoots imported were dipped in some liquid insecticide on arrival and inspected and treated in the propagating houses and in the field. These frequent inspections and treatments were continued until the palms were considered free from scale.

The problem became more complicated with the spread of the scale from imported palms to nearby seedlings. The infested seedling plantings found were included with the standard palms for inspection and treatment. With the inspection force available it was not possible to conduct adequate scouting inspections and systematically inspect the seedlings in the zones of possible spread.

Because of the high value at which the imported palms were held and the drastic treatment accepted as standard, the individual palm was the eradication unit. By careful inspection under favorable conditions a light infestation would be discovered before there was any spread to adjacent palms. The regular arrangement of the leaflets, or pinnae, along the midrib of the frond is such that a large percentage of the surface of the foliage may be readily inspected. The scale is conspicuous on a clean green leaf.

The palms when small could be inspected from the ground (fig. 14), but as they grew larger it was necessary to use stepladders (fig. 15), thus increasing greatly the time required for inspection. The fronds were pulled into position for inspection with a hook having a handle about 5 feet long.

In addition to the foliage, it was necessary at times to inspect the leaf bases of certain palms. This work was done when heavy leaf infestations were found or in checking heavily infested palms after treatment. The fiber bands were cut with an ax and pulled back to expose the bases.

The records indicated very effective inspection with the technique developed.

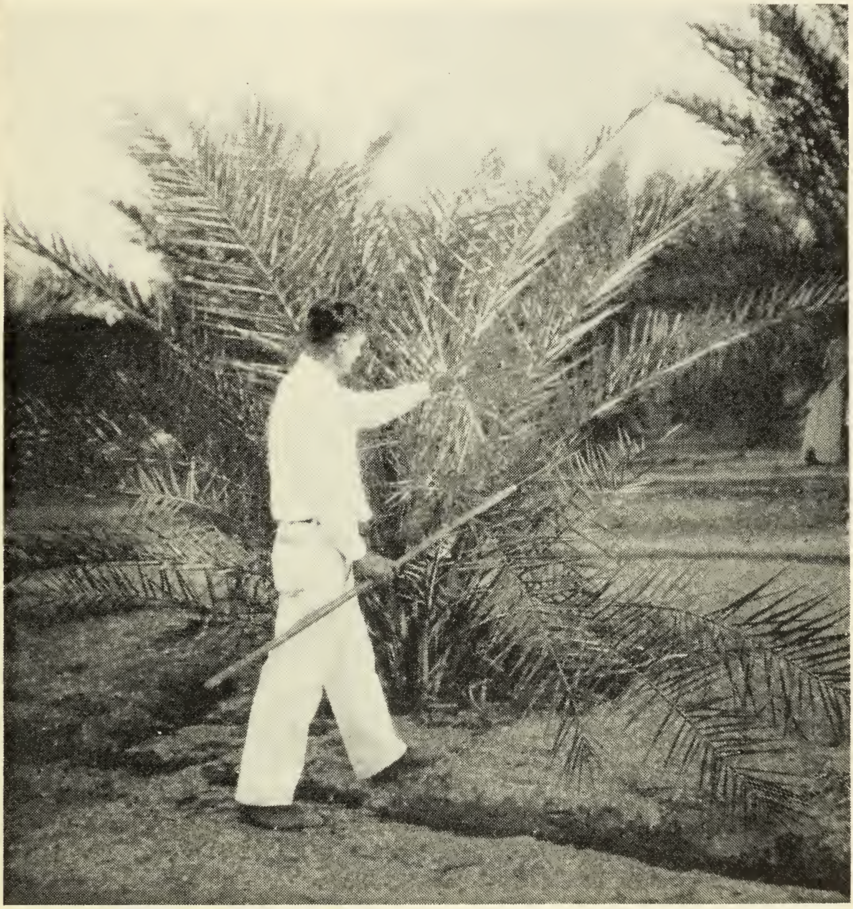

FIGURE 14.—Inspection of date palm from the ground. Note inspection hook.

The standard treatment for eradication on the individual palm was the torching method, modified in that the leaf bases were not removed unless the type of infestation or leaf-base inspection indicated that these were infested (figs. 16 and 17). Torching was not effective against scale on leaf bases protected by fiber (figs. 18 and 19).

Fumigation with hydrogen cyanide under metal containers was used to a large extent in the treatment of newly set offshoots and small palms. Many were freed from scale by this method, although in some cases torching had to be resorted to finally. In early years the lower portion of the palm trunk was sometimes torched and the top fumigated by the use of a metal container on a platform. This method, however, was discarded.

Pruning, or pruning followed by spraying, was sometimes used when the infestations were light. The method of treatment depended to a large extent on the type of infestation.

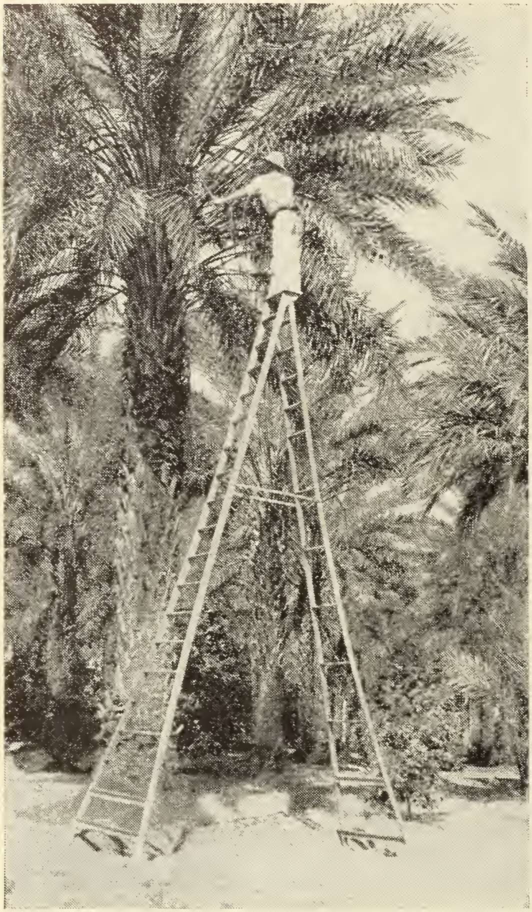

Figure 15.—Inspection of date palm from a 20-foot ladder.

By the modified torching method scale was often reduced to the extent that it would not be discovered by inspection and when found later would be called a recurrence. This prolonged the work but probably did not influence the final outcome in gardens that were consistently inspected until they were judged free from scale.

During the course of the work many worthless palms were found infested, and these were dug out and destroyed.

Although some early records indicated that the parlatoria date scale was resistant to hydrocyanic acid gas, later field-eradication reports showed that the insect could be eliminated in the field on offshoots except when there were leaf-base infestations. Shamblin (*9*) states that most of the small offshoots were freed from the scale by fumigation under galvanized tanks. Later field-eradication reports also indicated that the scale could be killed on the foliage with the newer oil sprays when good coverage could be obtained, but the sprays were equally ineffective against leaf-base infestation.

The efficacy of the torching method, then, was due primarily to defoliation and trunk pruning, which removed most of the scale and exposed the remainder to treatment. Torching, spraying, or fumigation following defoliation would probably be equally effective. The necessity of covering the trunk to confine the gas in the case of fumigation would make it less practical than spraying or torching. Torching was selected over spraying because it was more convenient.

There seemed to be no deleterious effect from defoliating a thrifty palm or from torching, if properly done (fig. 20). It was estimated, however, that the defoliation caused the loss of fruit for 2 years and half the crop in the third year, while the palm was producing a new top.

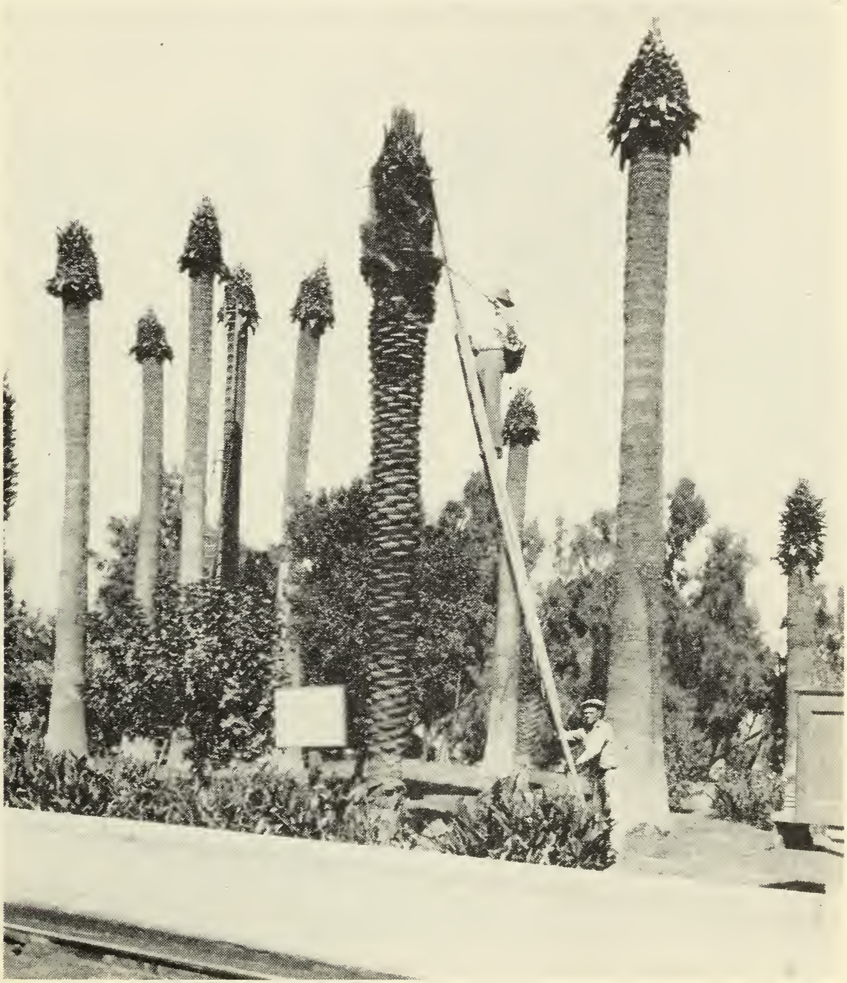

FIGURE 16.—Torching a date palm. This palm has previously been infested and treated and the leaf bases pruned to improve its appearance.

From the beginning of the eradication work in the Coachella Valley, records were kept of the inspections in the infested gardens. The tree and row number of each palm found infested was recorded, as well as the type of infestation and treatment and the name of the inspector who found the scale. The palm rows inspected by the different men were also recorded. A study of these records made it possible to evaluate the efficiency of inspection and treatment and also gave some idea of the habits of the scale.

The Federal and State quarantine regulations were enforced by the eradication force in cooperation with the State quarantine officials. Several thousand offshoots were moved under permit from quarantined areas in California to quarantined areas in Arizona and from Arizona to California, and there was no indication that the scale had been transported on these shipments. When permits were issued, the eradication history of the property on which the offshoots were grown was considered, as well as the result of inspection at the time of shipment.

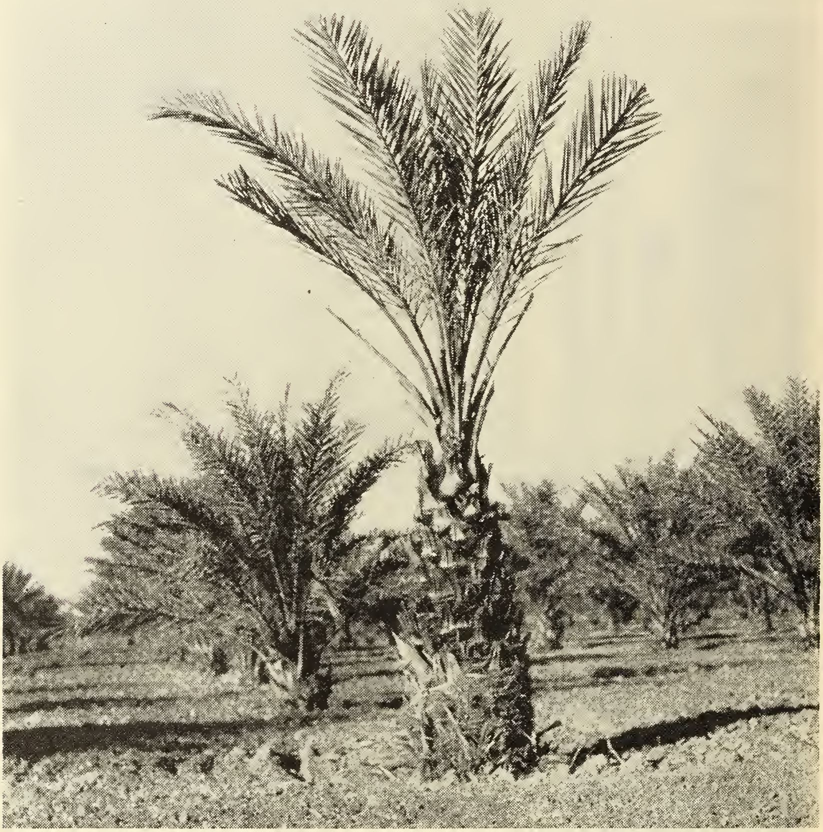

FIGURE 17.—Palm defoliated and torched on August 3, 1929, but leaf bases not removed. Picture taken December 16, 1929.

There was little movement of offshoots from the quarantined areas to outside areas. Permits were issued for the movement of a number of offshoots from the Deglet Noor nursery at Yuma to localities outside the quarantined areas. No parlatoria scale had been found in this planting since 1915, and the block in which the offshoots were cut was supposed to have been free of the red date scale. Also permits were given to ship a number of "heat-treated" offshoots outside the quarantined areas for experimental plantings. The treatment was developed by F. S. Stickney and consisted in holding the offshoots at a room temperature of approximately 150° F. until a temperature of approximately 125° was reached at the center of the base of the largest offshoot. No parlatoria scale was found on any of the offshoots moved out of the regulated areas.

Although there was no evidence of scale being transported from one quarantined area to another or to outside areas, there were instances of infested offshoots being moved within quarantined areas. Also infested offshoots were imported under permit but were kept in quarantine nurseries until free of parlatoria date scale.

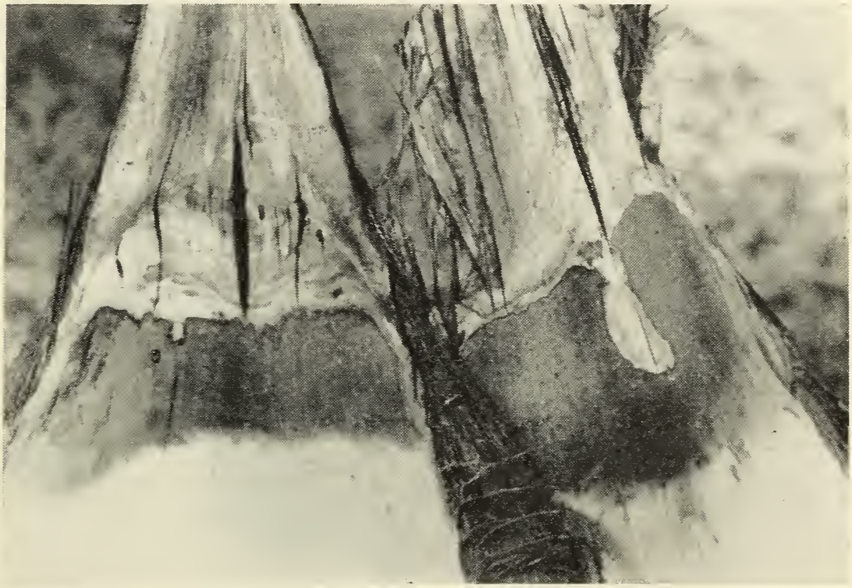

FIGURE 18.—Leaf bases from torched palm. Upper part of bases, which was exposed to flame, is dead and dry. Lower part, which was protected by fiber when torched, is alive and succulent and contains scale. Upper part of live area green because of light admitted by loosened fiber.

THE RED DATE SCALE AND THE PROBLEM OF ITS ERADICATION

In connection with parlatoria date scale eradication the desirability and feasibility of eradication of the red date scale were considered. This scale was included in Federal Quarantine No. 6, and the areas under quarantine that were defined and the regulations made for the interstate movement of date palms and date palm offshoots from these areas applied equally to the red date scale.

From its first appearance in Arizona the red date scale had not been considered so serious a pest as the parlatoria date scale, and little effort had been made towards its eradication, although its

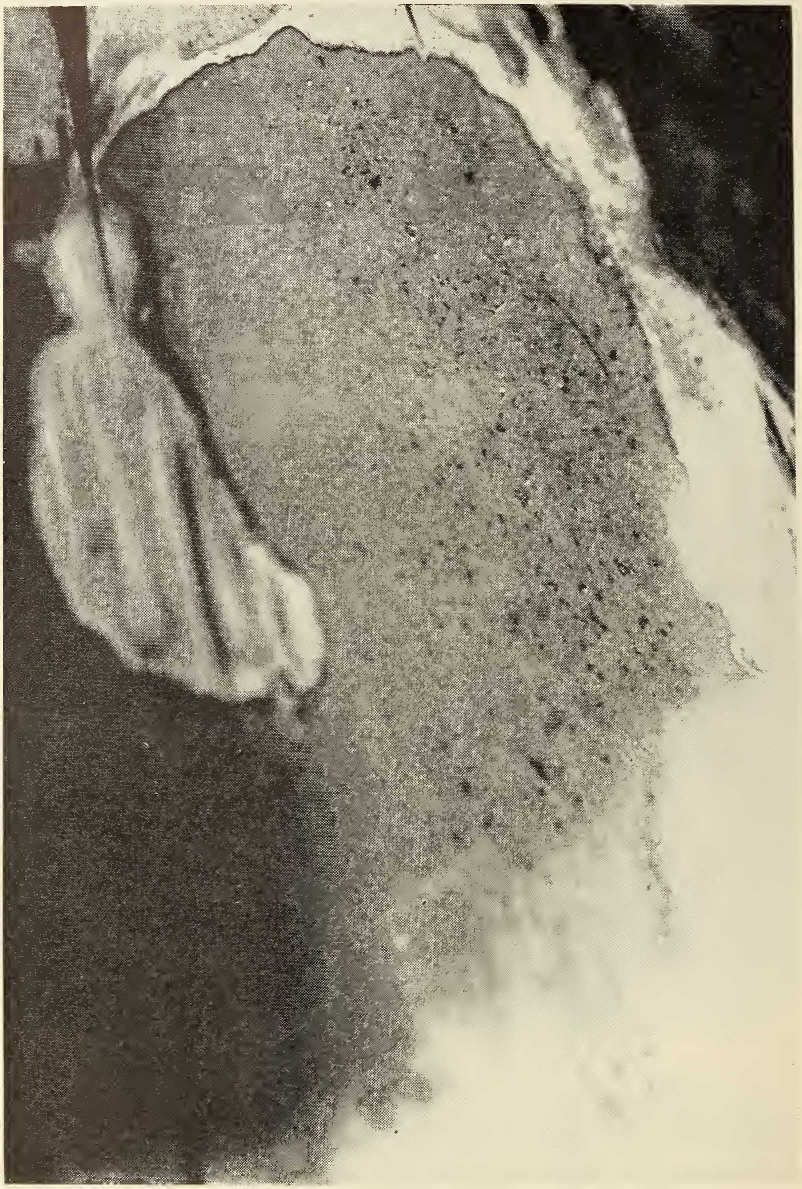

Figure 19.—Leaf base from palm that had been torched, showing live scale. Light area extending into live area of base shows where fiber was split before torching, exposing it to flame. The infested part of the leaf base was protected by fiber when torched.

biology had been studied and considerable work done on its control. By 1928 few considered it an important pest, and satisfactory yields were being obtained from infested palms with no control measures applied.

This scale was confined largely to the leaf bases and the bases of the fruit stems, seemingly being controlled satisfactorily on the fronds by the hot summer temperatures of the date-growing areas. Although the bases were heavily infested in many cases, direct damage was thought to be of little consequence because of the structure of the palm. No evidence was found of any toxic effect of the scale on the palm.

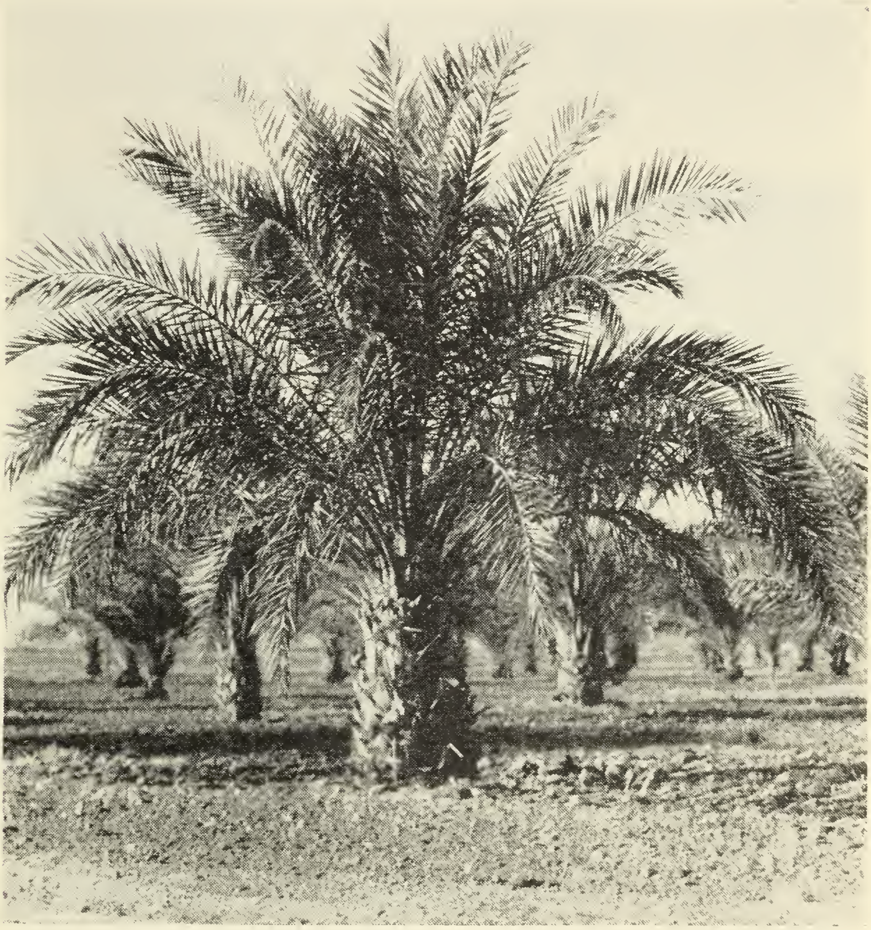

FIGURE 20.—Young palm that was defoliated and torched but from which leaf bases were not removed on October 27, 1927. Picture taken December 16, 1929.

Whereas there was some question as to the economic importance of the red date scale, there seemed to be no doubt as to the difficulty of its eradication. Practically all the standard palms and many of the seedling palms in the areas covered by the quarantine regulations were considered to be infested, as well as a few palms in various localities outside these areas.

As the scale was present for the most part on the leaf bases beneath the fiber, it was protected from liquid and gas insecticides. Shamblin (*9*) states, however, that in the treatment of imported palms on the experimental farm at Phoenix for the parlatoria date scale the red date scale was also eradicated. The treatment in that case included complete defoliation and the removal of all the leaf bases from the palms. Such treatment of all the palms known or suspected of being infested was not feasible, and inspection for the red date scale was very uncertain.

CONCLUSIONS DRAWN FROM THE SURVEY AND REVIEW OF FORMER ERADICATION METHODS

The growing of dates in the United States was a comparatively new industry. It had passed from the experimental stage, for dates of good quality had been grown over a large area in the Southwest and satisfactory cultural methods had been developed (fig. 21). The supply of offshoots available was sufficient to permit a rapid increase in acreage.

The parlatoria date scale was without doubt a serious pest of the date palm in the Southwest and it seemed that the possibilities of commercial date growing would be decidedly limited if a satisfactory control were not worked out or the scale eradicated. Artificial control would in all probability be difficult and expensive. Control with parasites from the Old World gardens was possible but uncertain. Eradication seemed feasible, as well as desirable to save the industry an annual expense, which would become larger with spread of the scale and increase in acreage and growth of the palms.

It had been proved that the scale could be eliminated on the individual palm and by repeated inspection and prompt treatment could be eradicated in a garden. The distance of spread by natural means from a heavy infestation seemed limited and fairly well defined. The survey of 1928 probably located most of the heavy infestations, and those overlooked were apparently small plantings of abandoned seedlings in the infested areas or in areas of scattered small plantings with comparatively few palms.

It seemed reasonable to presume that the heavy infestations when discovered could be immediately reduced to the point where there would be no further spread, that incipient infestations could be located by repeated inspection of all palms in the infested areas, and that by intensive work in the known infested plantings the scale in these plantings could be eradicated.

There were several instances of infested offshoots being moved without permit within the different date-growing areas, and offshoots had been moved from properties that were considered free of scale at the time of shipment but were found infested later. There was evidence that pollen from seedlings in the infested areas had been used outside those areas. Although spread by this means was not considered probable, it seemed possible that scale could be carried in that way. Whereas the limit set for natural spread seemed safe, it was realized that the scale might be carried longer distances. Any infestation outside the designated infested districts could be located by survey and inspection of the desert areas of southern Arizona and California.

Many seedling date, Canary Island, and other types of palms were growing as ornamentals in citrus districts of California not considered suitable for date growing. There seemed to be little chance that the parlatoria date scale had become established in any of these citrus-growing districts and even less chance, if established there, of it being transported to the date-growing areas. Date palms had been moved from the Southwest into Mexico, but it was not probable that these were infested with the scale.

FIGURE 21.—Date palm garden in the Coachella Valley, Calif.

The eradication methods developed during the course of the work seemed adequate, but a much larger force of inspectors than had been available was needed so that the necessary survey, inspection, treatment, and clean-up work could be accomplished. Time was also an important factor, for the height of the palms and acreage in gardens was increasing rapidly, and the scale had spread to a point where a large acreage of presumably noninfested palms was threatened.

It was estimated that the cost of eradication work for the period January 1, 1929, to June 30, 1930, would be $130,580. The funds necessary for the continuation of the project, if such a plan seemed advisable, would naturally be based on the information gathered as the work progressed. It was thought that by the end of about 2 years certain areas could be dropped as free from scale, and this process continued until the entire date-growing area was considered free.

REORGANIZATION OF THE DATE SCALE PROJECT

In September 1928 the California Department of Agriculture called a meeting of date growers to discuss the parlatoria date scale situation. The meeting was attended by date growers of Arizona and California and representatives of the State entomologist's office of Arizona, the California Department of Agriculture, and the Federal Horticultural Board. Eradication of the scale was considered to be feasible, and a program of procedure was approved. It was recognized that the eradication must be a cooperative project, financed by the two States and the Federal Government, under the leadership of the Federal Horticultural Board, but with the various organizations represented at the meeting actively sharing in the work. It was also recognized that the sooner intensive work was begun the greater would be the chance of success and the lower the cost, for the acreage and size of the palms were increasing rapidly and the scale situation was such that wide spread seemed imminent. Congress and the State legislatures were, therefore, to be asked to appropriate adequate funds for the project.

In December $25,000 was allotted to the project from the emergency fund of the State of California to carry the work as planned until additional funds were available July 1, 1929. The California legislature appropriated an additional $25,000 and the Arizona legislature $20,000 for the biennium July 1, 1929, to June 30, 1931. These allotments, together with the Federal funds appropriated, made approximately $234,160 for the 2½ years.

The general program as approved was to follow the 1928 survey with a more careful inspection of the infested and adjoining districts to determine more definitely the infested areas (areas of natural spread from known infestations), carry on intensive eradication work in the infested gardens, inspect at least twice a year the noninfested plantings in the infested areas and once a year palms in the other date-growing districts in the eradication areas (Yuma Valley, Salt River Valley, Coachella Valley, and Imperial Valley) where the chance of infestation by natural spread seemed remote but where there seemed to be some danger of spread from movement of offshoots or use of pollen from infested areas, locate and inspect once palms outside the eradication areas, locate and inspect fan and Canary Island palms in the infested areas, dig out or prune abandoned palms in the infested areas to facilitate inspection, and enforce Federal and State quarantines. This program, to be modified as additional information was obtained, was to be followed until the project was completed.

Headquarters of the project were to be at Indio, Calif., in the Coachella Valley, and suboffices at El Centro, Calif., in the Imperial Valley, Phoenix, Ariz., in the Salt River Valley, and Yuma, Ariz., in the Yuma Valley. Close cooperation was to be maintained with the State entomologist's office in Arizona and the County agricultural commissioners of Riverside and Imperial Counties and the California Department of Agriculture.

With the limited number of inspectors available in the latter part of 1928, work in the Coachella Valley was concentrated in the known infested plantings, with some hurried inspection in plantings near the infested gardens. During that period there was a force of 12 inspectors, 9 paid by the Federal Horticultural Board, 2 by the Bureau of Plant Industry, of the United States Department of Agriculture, and 1 by the date growers. Nine of the inspectors were stationed in the Coachella Valley, 1 in the Salt River Valley, 1 in the Yuma Valley, and 1 in the Imperial Valley. The 1928 survey had indicated that the greatest danger of immediate spread was in the Coachella Valley. With adequate funds available in January 1929, the inspection force was increased as rapidly as suitable men could be obtained and trained. There were 36 full-time inspectors in December 1929, and the force was maintained at about that size until reduction began in 1932, as the project approached completion. The new men were instructed as to inspection procedure and were then assigned rows of palms in infested gardens, with experienced men inspecting the same rows behind them. Their efficiency was judged by their records of finding scale as compared with those of the trained men.

From the lists of plantings prepared during the survey of 1928 further lists were to be made of plantings in each of the districts requiring 5 or more man-days for inspection and those requiring less. The former plantings were to be inspected by crews of five or more men working under the direction of inspection foremen and the latter by men working in pairs. The inspection of the larger plantings was termed "routine" inspection and that of the smaller plantings "scout" inspection. (See pp. 41–43.) The scout inspectors were also supposed to locate palms that had been overlooked.

It was planned to station enough men in the Imperial, Yuma, and Phoenix areas to take care of the scouting, survey, and offshoot (quarantine) inspection. The routine inspectors, together with scout inspectors, were stationed in the Coachella Valley, where most of the commercial gardens were located. Crews from Indio, assisted by the local inspectors in the districts where the work was carried on, were to conduct the routine inspection in the Imperial, Salt River, and Yuma Valleys. Survey inspection outside the eradication areas was to be conducted by scout inspectors from the nearest office. The inspector in charge of treatment at Indio also supervised the clean-up work in the Coachella Valley and the treatment in the other areas until the men in charge of these areas were fully conversant with the methods.

Inspection reports were to be made in duplicate in the areas outside the Coachella Valley, one copy to be sent to Indio and the other retained, and files and maps were kept at each office.

ERADICATION PROCEDURE

There were three fundamental operations in the eradication work, namely, a survey to locate the hosts of the scale, inspection to discover infested palms, and treatment to eliminate the scale. Two other operations supplementary to the above were the enforcement of quarantine regulations, to prevent the spread of the scale by movement of palms or offshoots during the campaign, and clean-up work to facilitate inspection.

Survey

The primary purpose of the survey was to locate hosts of the scale, but the palms were also inspected when found. The first survey of the date-growing areas in 1928 was of necessity hurried and the accompanying inspection more or less superficial, little ladder work being done. It was realized that many palms must have been overlooked. When the project was reorganized and systematic inspection under way in the eradication areas, one of the duties of the scout inspectors was to locate unlisted palms. These new palms were inspected, reports made, and the plantings added to the lists. Many palms that had been previously overlooked were found in this way.

It seemed probable that the scout inspectors, after they had become familiar with a district, would follow certain routes and would be less apt to find unlisted palms. Therefore inspectors unfamiliar with a district were given the list in the hope that in locating the listed palms they would pick up palms overlooked by the preceding inspectors.

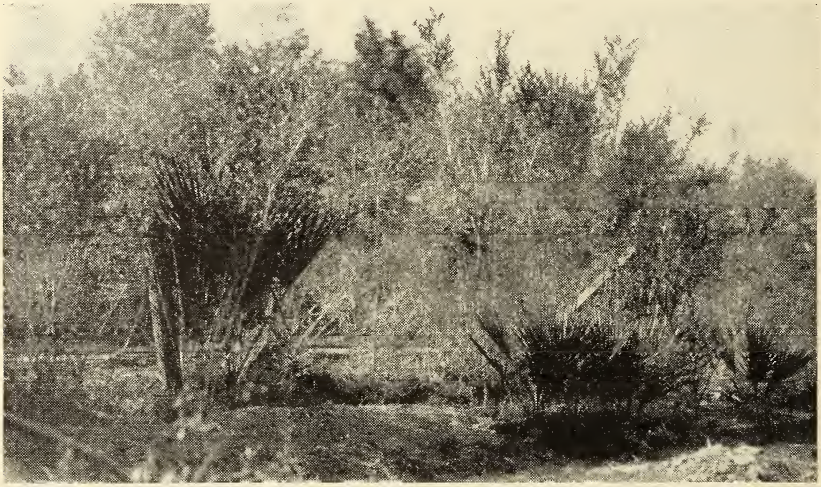

Figure 22.—Small volunteer fan and date palms along irrigation ditch and fence.

Finally a section-by-section survey was conducted in the infested districts and in adjoining areas, so called because the section was taken as the unit rather than the district. No inspection of listed palms was made by the inspectors while on this survey work. Each section was taken separately and a report was submitted with a map drawn by the inspector showing what part was cultivated and what crop was planted; or if not cultivated, the type of natural growth. Making this map and description served as a sort of check for the inspectors and determined which sections should be resurveyed. If parts of a section were covered with mesquite or other growth that obstructed the view, these parts were scouted thoroughly. The dense growths of weeds along irrigation ditchbanks and windbreaks were carefully scouted. Many unlisted palms, mostly small, were found in this survey. Certain areas were covered twice in this manner and others three or more times.

Certain palms found were added to the lists for further inspection, some were dug out immediately, and others, because of the history of the district where they were found, received no further attention.

In addition to the regular survey work, the properties on which palms had been dug out were checked at intervals for small palms that had been overlooked at the time of digging or had grown from seed or from stumps or parts of stumps left in the ground.

This intensive survey work resulted in finding many infested small palms in the infested areas but none outside (figs. 22 and 23).

As soon as the work was well under way in the eradication areas and time permitted, scouting was begun in outside areas. In Arizona there seemed some chance that infested offshoots had been moved outside the eradication areas. Standard offshoots had been distributed in small lots to individuals in the early efforts to establish the industry and, while most of them probably died, there seemed a chance that one or more infested offshoots had survived in localities where there was no particular interest in date growing and inspection was not being carried on. Since interest in date growing had revived in Arizona, thousands of standard offshoots had been brought in from the Coachella Valley and some from the Imperial Valley. Although the movement of offshoots between the States had been carefully supervised, offshoots had been moved from properties which later were found infested. The movement of offshoots in Arizona was also carefully supervised by the State entomologist's office, but infested offshoots from a seedling planting found infested in 1927 were traced to other properties.

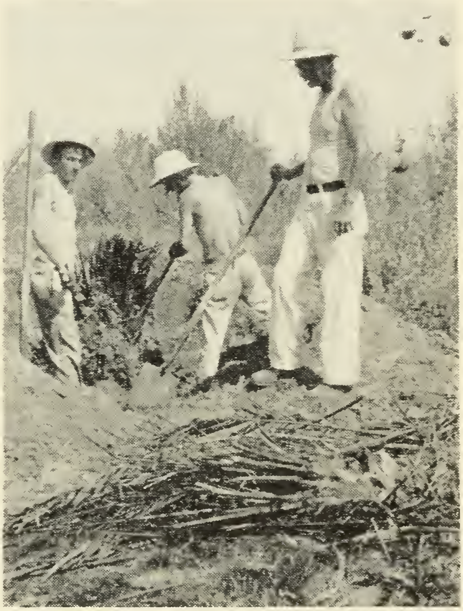

FIGURE 23.—Digging out date palm trunk that had been buried in silt from irrigation canal. The foliage of the palm was found heavily infested. A thick growth of weeds has been cleared away.

During the course of the eradication work in Arizona 2,462 standard and 2,118 seedling palms were located and inspected outside the eradication areas. None was found infested.

The Rio Grande Valley in Texas was not considered an eradication area because of its history. As has been noted, the previously infested planting of standard palms at Laredo was inspected casually in 1928, as were the nearby seedling palms, and no parlatoria scale was found. This planting was apparently free from scale in 1919, but, if infested, the time elapsing between these inspections would be sufficient for the scale to develop to the extent that it would be discovered by only a casual inspection. In 1932, however, 2 inspectors from the date scale project working with 2 inspectors of the Texas Department of Agriculture carefully inspected this property, together with nearby seedlings, from the ground and from ladders, and no scale was found. Many palms were inspected in the city of Laredo and at other localities south to Brownsville. The total number of date palms inspected was 10,278. Included in this total were a number of standard palms at the Weslaco Experiment Station, which had been "heat-treated" and were being inspected at intervals, and one presumably standard palm from Death Valley in California.

In 1931, 1,651 date palms were inspected in the Palo Verde Valley. Included in these were 20 palms from Yuma and 159 from the Coachella Valley. Of those from the Coachella Valley 59 were from a garden that was later found infested. This inspection was carried on in cooperation with the resident county agricultural inspector. Also 320 date palms and 141 offshoots were inspected on the Furnace Creek Ranch in Death Valley. Other palms were inspected at small desert towns along the railroads and in isolated desert localities. Palm inspections were made in various localities in the citrus district from San Bernardino to Los Angeles. In this citrus belt 1,686 date palms were located and inspected. Unless there was some reason for closer inspection, only ground work was done. If an infested offshoot had been planted, it could be readily inspected from the ground for several years. If it had grown so large that it could not be inspected from the ground, the infestation would probably be so heavy that no ladder work would be necessary to discover it.

No parlatoria scale was found outside the eradication areas.

INSPECTION

The inspection technique developed during the course of the work has been described. It had been found that a 20-foot stepladder was as tall a one as was practical to use. Straight extension ladders were employed for the taller palms.

A tower was designed and built which could be mounted on a truck for the inspection of tall palms in gardens. On the top of the tower was a platform that could be raised 30 feet above the bed of the truck. There were supplemental platforms which could be extended laterally so that palms could be inspected in two rows (figs. 24 and 25).

Many tall palms not in gardens could not be inspected from the tower. Work on these extension ladders was difficult because of lack of rigidity of the ladders and the lack of freedom of movement by the inspector. Braces were constructed to make the ladders more rigid when extended, and linesmen's belts were used by inspectors when working in the tops of tall palms (fig. 26).

In one infested garden of 100 large palms the owner built several tourist cabins and sheds, making it impossible to inspect certain of the palms with the ordinary equipment. A ladder was built which would extend out over a support and into the foliage of the palm. The steps on the ladder were constructed so that they would be

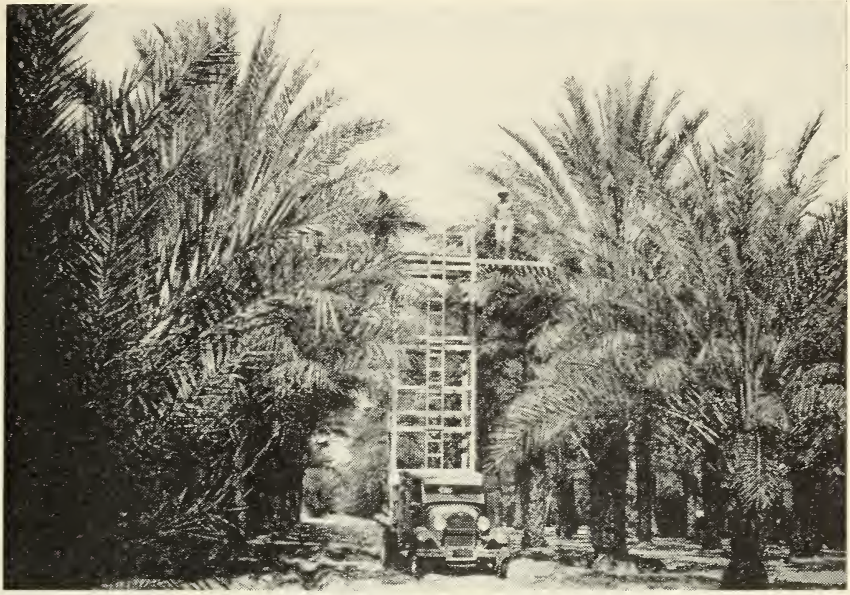

FIGURE 24.—Inspection from tower.

parallel to the ground, forming something like a flight of stairs. Wire cables extended from one end of the ladder to the other, bracing the ladder and affording the inspector a handhold (fig. 27).

When the date plantings in the eradication areas were listed for periodic inspection, those requiring 5 or more man-days were listed separately from those requiring 4 man-days or less. The larger plantings were inspected by crews of five or more men working under the direction of a foreman and the smaller plantings by men

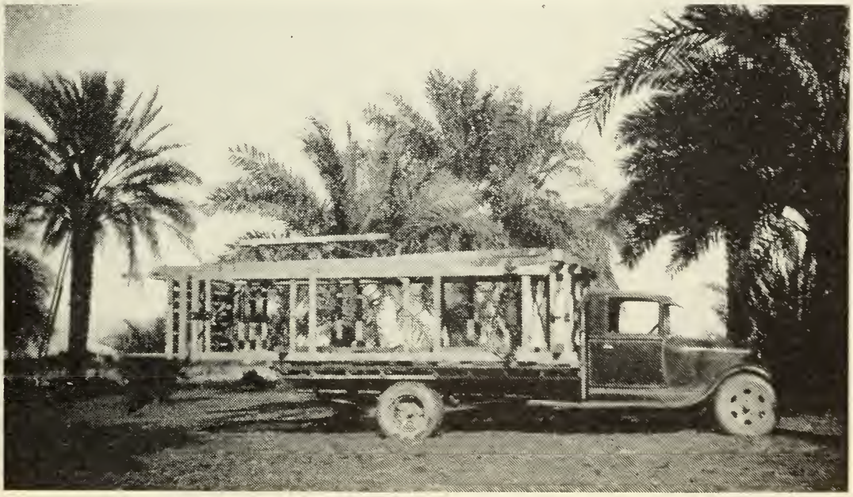

FIGURE 25.—Inspection tower on truck.

working in pairs. The two types of inspection were called "routine" and "scouting," although the palms were supposed to be inspected with equal care in each case. One reason for this arrangement was, of course, economy in transportation of men and equipment.

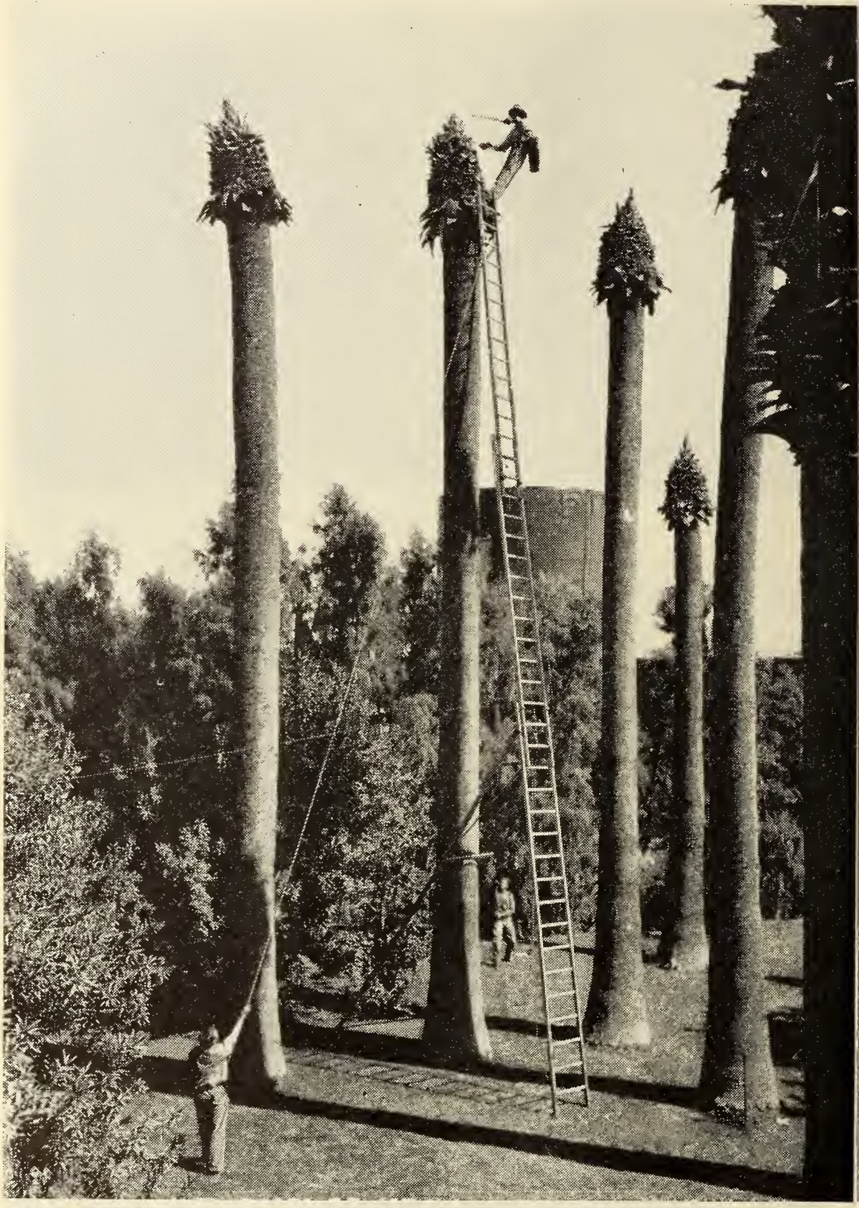

FIGURE 26.—Spraying defoliated fan palm. Inspector using linesman's belt with extension.

Routine inspection was planned in advance so that it would not be interrupted by irrigation and other operations in the gardens. The list of gardens to be inspected was given to the foreman so that he could have the necessary equipment available. The foreman was given report forms and maps of the gardens; and after each planting was inspected a report was turned in giving the number of palms inspected, the number of palms found infested and by which inspectors, location of the infested palms in the garden, type of infestation in detail, man-days required for ground, ladder, and tower inspection, assignment of inspectors as to rows, condition of the palms for inspection, and any other comments on conditions which would affect the work.

The routine inspection in the infested gardens was very careful. Each leaf was examined on both the upper and lower surfaces, and all the time considered necessary by the foreman was taken. Approximately the same procedure was followed in noninfested gardens in the infested districts and certain gardens adjoining the infested districts, but the work was somewhat faster and the inspections were made with less frequency.

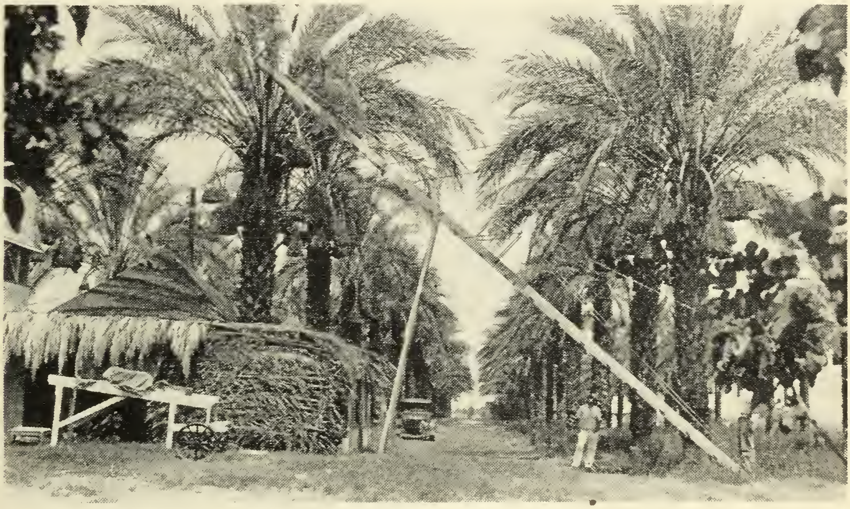

FIGURE 27.—Ladder used for inspection where stepladders could not be set.

The scouting inspection was approximately the same as the routine inspection except that maps of plantings were seldom necessary. Whereas the scouting inspection was supposed to be as carefully done, there was a tendency to speed up the work. To overcome this tendency, scout inspectors were assigned to routine crews at intervals. Furthermore, the smaller noninfested plantings were inspected more frequently than the noninfested plantings inspected by routine crews. The smaller plantings were in general more difficult to inspect owing to the location of the palms in regard to buildings and other obstructions. Scout inspectors also did quarantine and survey work.

Although parlatoria date scale inspection was very effective, it was not perfect, for even with the most careful inspection light infestations would be overlooked. While most of the surface of the palm could be seen by the inspector by careful manipulation of the fronds, there would be a certain portion of it that could not be seen. The surface missed would probably differ with different inspectors, for no two would examine the frond from exactly the same angle. Also inspectors were not equally efficient and all perhaps had lapses in efficiency, especially when scale was not being found frequently. For these and other reasons inspectors were assigned different rows at each inspection of a garden. It was also possible for a few scales to be on a frond in a position not to be discovered by the inspection methods in use. In this latter case the scale would in time increase in numbers and spread to locations where it could readily be found. As it was very desirable that the infested palms be found before there was any spread to adjoining palms, frequent inspections were necessary.

The tentative standard set for frequency of routine inspection in commercial well-pruned gardens was six a year in infested gardens, two a year in noninfested gardens in infested areas, and one a year in those requiring periodic inspection outside the infested areas. Conditions varied in different plantings, of course, and the necessary inspection and other work was to be decided as more information was accumulated.

In planning the work it was necessary to decide the approximate time required to clean up an infested garden and how long inspection in noninfested gardens in the infested areas should be carried on before all incipient infestations were discovered. It was also necessary to determine how much inspection would be required outside the infested areas. The decisions were based on the study of the past work.

The time necessary to clean up an infested garden in the Coachella Valley during the period 1914–28 varied considerably. Certain gardens that were heavily infested when the eradication work began in the valley were not free from scale until 1927 or 1928, although there was a general reduction in infestation. The reports on these gardens indicated considerable experimentation in methods in the early work. As the work progressed improvement in treatment and inspection methods was indicated. There were indications also that eradication in certain gardens was delayed by scale coming in from undiscovered heavy infestations. With the methods developed and with a force of inspectors large enough to carry on adequate inspection in the infested gardens and in the districts as a whole, it seemed reasonable that infested gardens could be cleaned more quickly. Gardens found newly infested from 1920 on were cleaned up in much shorter time than the initial infestations.

Histories of the infested gardens in the Coachella Valley indicated that if periodic inspections were carried on for a year in a garden and no scale was found, the garden was probably free from scale. There were cases, however, where scale was found in such gardens, owing in some instances probably to reinfestation from sources outside and in others to leaf-base infestation or poor inspection conditions.

In the preliminary planning for the reorganized work it was decided that 3 years' intensive inspection in the infested properties would discover all palms which were infested when the work was begun and that 2 years' additional inspection would be necessary to insure against light infestations due to possible spread during the course of the eradication work or leaf-base infestation being overlooked. It was also decided tentatively that 3 years of systematic inspection in noninfested plantings in the infested areas after the centers of spread had been eliminated would be sufficient to discover all incipient infestations. In certain areas outside the infested areas where repeated inspections were thought necessary one inspection a year was considered sufficient. This also was tentative, and modifications were to be made if additional information showed them to be advisable.

Fan and Canary Island Palm Inspection

Early history of the work indicated that the native fan palm would be a negligible factor in the eradication problem and the Canary Island palm a minor factor. The fan palm was considered a doubtful host of the scale but the Canary Island palm a favored host. Very few palms of other species were found in the infested areas. Many fan palms were recorded in the Coachella Valley along roads and singly or in groups around buildings, but very few Canary Island palms were found, and these usually were growing with ornamental date palms. There were also many fan palms in the other areas, and a considerable number of Canary Island palms in the towns and cities. There were also a few Canary Island palms near houses on the farms, usually with date palms.

As previously noted, the spread of the parlatoria date scale seemed almost entirely by the movement of offshoots or by natural spread from heavy infestations, the latter being limited in distance. Fan and Canary Island palms were not propagated from offshoots. The limit of natural spread apparently was not over 2 miles.

During the 1928 survey no palms other than the date palm were listed and only those in the immediate vicinity of infested date palms were inspected. Several Canary Island palms and very small fan palms had been found infested. Large fan palms near heavily infested date palms also had been found lightly infested.

In 1930 systematic inspection of fan and Canary Island palms in the infested areas was begun. In the Coachella Valley 44 fan palms and 3 date palms in a planting of 266 fan palms, 13 date palms, and 3 Canary Island palms in a small park around the Southern Pacific depot were found infested. One of the date palms in the midst of a group of fan palms was heavily infested. Several infested date palms had been found on the Southern Pacific grounds when the town of Indio was found infested in 1927. This infested property had been apparently cleaned up. The heavily infested date palm found during fan palm inspection had evidently been lightly infested in 1927 but had been overlooked in 1928 and 1929 and not inspected, probably because of its location. The infestation had developed until there was considerable spread by 1930. All infested fan palms found were within 300 feet of the infested date palm and about 75 percent of them within 75 feet of the date palm. No other infested fan palms and no infested Canary Island palms were found in the Coachella Valley, although 3,109 were inspected in 1930. Toward the end of the eradication work further fan palm inspections were made, and no scale was found.

In the other areas numerous small fan palms were found infested, all of these being in the immediate vicinity of heavily infested date palms. Very few large fan palms were found infested, and these also were near heavily infested date palms. The Canary Island palms in the infested area in the Imperial Valley were listed, and many were inspected several times. A few individual Canary Island palms were found infested on properties where infested date palms had been found, and 31 Canary Island palms were found infested in a cemetery. There were 73 Canary Island and 65 fan palms, but no date palms, on this property. It was in an infested district approximately a mile from 2 heavy infestations.

In general, several inspections were made of the fan palms in the immediate vicinity of infested date palms. Most of the other fan palms in the infested areas were inspected at least once. The small volunteer fan palms on infested properties were adequately taken care of by the survey work in addition to the regular inspection. Less inspection was given Canary Island palms than date palms but considerably more than fan palms.

RECORDS

The reports turned in by the inspectors furnished the data on which the future eradication work was planned. In the 1928 survey, as previously stated, all notes were assembled, segregated, and filed under each property. A summary card was prepared for each property on which there were any data and the information from the survey reports was added. Cards were prepared from the survey reports for those properties on which no data had been found. Maps of the different eradication areas—Coachella Valley, Imperial Valley, Salt River Valley, and Yuma Valley—were obtained and all infested and noninfested date plantings located on them. These large maps were supplemented by smaller, more detailed township, town, and city maps, and also maps of the infested gardens. Charts were prepared of the infested properties in each area, giving the date of each inspection and the number of infested palms found. Charts of noninfested properties requiring routine inspection were also made.

Lists were prepared of all properties located in the different areas. In one list in each area the properties were given under the owners' names alphabetically and in another by range, township, and section. In the latter case the number and variety of palms were noted. These were general reference lists. Routine and scouting lists, by districts, were prepared for inspection and lists of properties requiring palm digging, pruning, leaf-base removal, and other types of work were made.

As reports on the different phases of the work were turned in, they were checked carefully and filed and the added information noted on the maps, charts, and lists. The whole set-up was planned so that the history and present eradication status of each area, district, garden, and each palm which had been infested was immediately available.

In the general plans tentative standards of inspection and other phases of the work were set. These were modified on the information turned in as the work progressed; in fact, the work necessary in each area, district, planting, and on each infested palm was determined from the study of the daily reports.

Treatment

Defoliation and torching, with modifications according to the type of infestation (p. 27), was the best treatment available and was effective. Any lingering infestations on the leaf bases, it was believed, would be discovered by follow-up inspections and could then be finally eliminated.

As has been noted, many of the palms found infested in the past were seedlings of no value and were dug out. The same was anticipated in the future work.

Quarantine

The Federal and State quarantine regulations covering the interstate and intrastate movement of date palms and date palm offshoots were enforced in the date-growing areas cooperatively by the personnel of the eradication project and State quarantine officials. The interstate movement was negligible except between the eradication areas in California and Arizona. Several thousand offshoots were shipped from California to Arizona each year, and some were shipped from Arizona to California. Most of the offshoots cut, however, were for local planting. Offshoots were certified for both interstate and intrastate movement on the basis of inspection and the history of the plantings from which they were taken. All offshoots from gardens that had been infested in the past were inspected at the time of cutting, for at that time the most effective inspections could be made.

Clean-Up Work

In the 1928 survey many abandoned seedling plantings were found in the infested areas. Most of these were difficult and some were impossible to inspect. The scale could build up in some of these plantings to a point where there would be considerable spread before the infestation could be located by inspection. It was essential to the success of the project that these palms be dug out or pruned and the brush cleared away so that they could be properly inspected.

Neglected seedling plantings were listed and permission was asked of the owners to dig them out. Some of the owners consented to the removal of all their palms and others to the removal of all but a few around the house or building site. In other cases consent was obtained to thin out seedling jungles (figs. 28 and 29). Permission was obtained to get all abandoned seedlings in shape for inspection, and as soon as funds were available this work was begun. The lists of palms for digging were kept up to date, and the palms remaining from plantings partially dug were kept on the lists, for the owners sometimes changed their minds or ownerships changed. All seedling palms that had been treated for scale were also on the lists, and many of these were dug out and destroyed with the consent of the owners. Toward the close of the project a number of owners of ornamental date palms that had been infested allowed their removal if replaced by standard variety offshoots. These offshoots for replacement were contributed by date growers. From 1929 to the close of the project 47,881 valueless date palms were dug out and destroyed. This number does not include the small palms dug out during the survey work or during regular inspection. Of 4,520 palms found infested from January 1, 1928, to the end of the project, 3,079 were dug out and destroyed when first found. Others were dug out later.

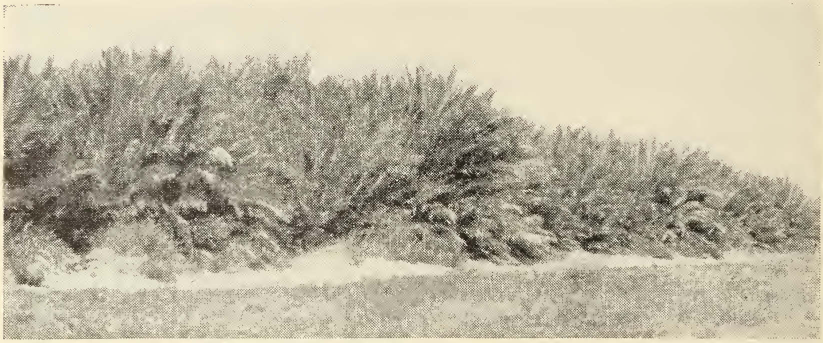

FIGURE 28.—Unthinned seedling row.

Brush was cleared from around 1,074 abandoned palms, and the palms were pruned for inspection. In many commercial and ornamental plantings excessive foliage made inspection difficult, and lists were compiled from inspection reports of plantings needing pruning. A total of 3,510 palms were pruned to facilitate inspection (fig. 30, *A* and *B*).

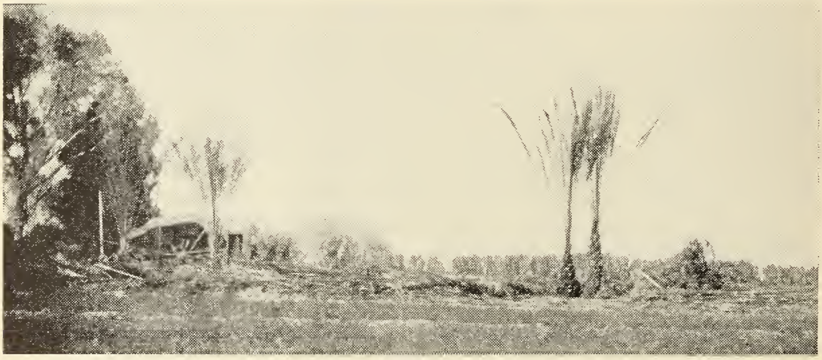

FIGURE 29.—Seedling row in figure 28 after clean-up. Four male palms left.

During the course of the periodic inspections in infested plantings the fiber on the palms suspected of having leaf-base infestations was split and the bases inspected. Toward the close of the project all known previously infested palms were listed and segregated as follows: Those whose history indicated that no further work was necessary, those to be dug, and those to have the leaf bases removed. The leaf bases were removed from a total of 584 palms during this final clean-up work (fig. 31).

ERADICATION IN THE INDIVIDUAL PLANTING

The general eradication plan was the same for all plantings. First of all, the planting was put in such condition that it could be inspected effectively. Then systematic inspection was carried on to locate infested palms and treatment to eliminate the scale. Finally the leaf bases were removed if there seemed any possibility of undiscovered leaf-base infestation. The property was also scouted thoroughly for small volunteer palms.

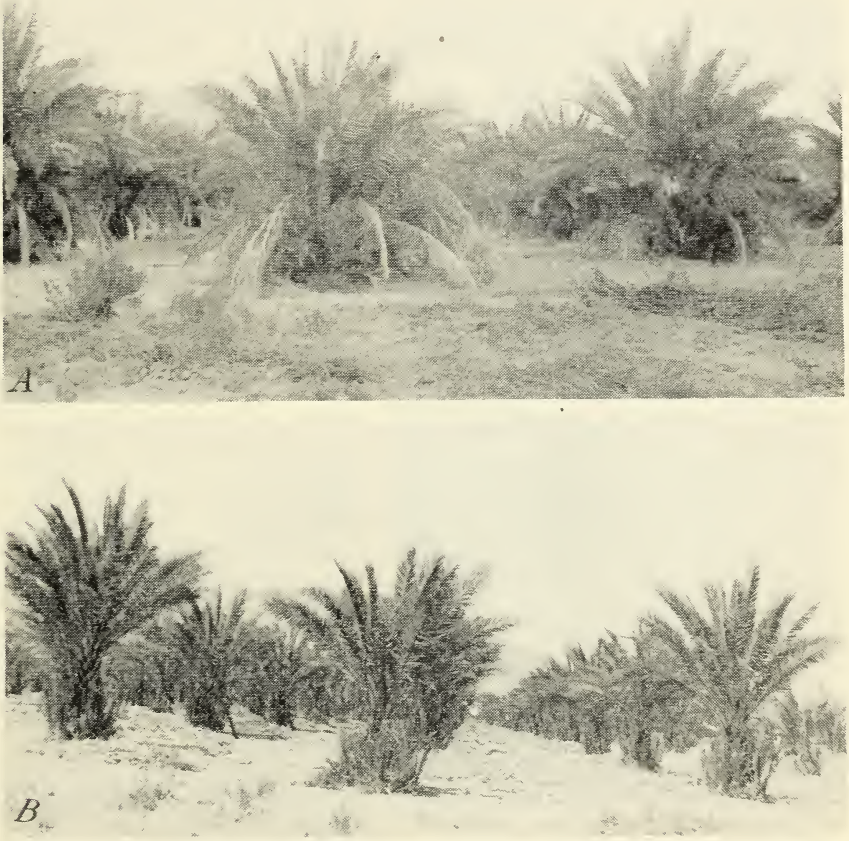

FIGURE 30.—*A*, Young commercial date garden, bushy with offshoot foliage. Difficult to inspect. *B*, Garden pruned to facilitate inspection.

The procedure, however, varied considerably in the different gardens, which ranged from unthinned seedling plantings overgrown with brush to well-kept commercial plantings. To illustrate this difference in procedure, eradication work in certain gardens will be described.

Boyer Garden

The Boyer garden (fig. 32), at Indio, Calif., is a typical well-kept commercial garden. It illustrates the spread of the scale within a garden, for presumably the infestation consisted of one rather heavily infested palm and a number of lightly infested palms to which the scale had spread from the first. This was one of the early gardens in the Indio district. It was planted with offshoots of the 1914 and 1915 importations and Yuma palms obtained in 1919. Two palms were recorded as infested in this planting in 1920. Inspection records showed no scale found during annual inspections to 1924. No further inspection was recorded until December 1927, when the Indio district was being scouted. Three casual inspections were made in 1928 and one in March 1929, and no scale was found.

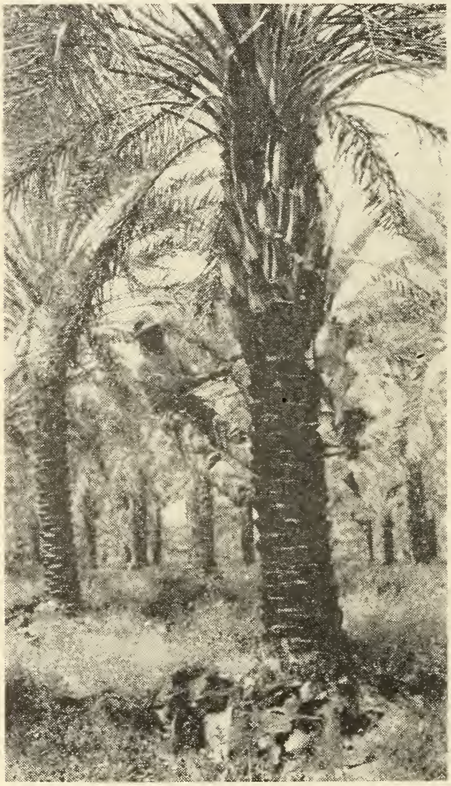
Figure 31.—Removing leaf bases.

During the first careful inspection of the valley, in August 1929, five infested palms were found in this garden. One was rather heavily infested, the tips of two offshoot leaves being white and scattered scale appearing on several leaves and on the fruit. Only one scale was found on each of three of the other palms and less than a dozen scales on the remaining one. The offshoots were cut from the heavily infested palm and destroyed, and the palm was defoliated and torched. The infested leaves were cut from the other palms, and all were pruned lightly.

The garden was inspected again in October 1929. Three of the four palms that were pruned after the last inspection and 6 additional palms showed scales ranging from 1 to about 100 per palm. The inspection was finished on the 28th, and all the infested leaves were cut off and the palms pruned pending harvest. Seven were defoliated and torched, 1 was dug out and destroyed, and 1, on which a single scale had been found, was pruned on December 5, after the fruit had been harvested.

In January 1930 a "spot" inspection was made. In most infested gardens, after systematic inspection was under way, certain areas, or "spots," were marked off for more frequent examination than the remainder of the garden received. In this garden the spot included

13 rows in bock 1 (fig. 32), in which the heavily infested palm had been found. Five lightly infested palms were found. Three of these were torched and the other 2, which had only 1 scale each, were pruned.

The entire garden was inspected in February and three lightly infested palms were found, one of which had been infested during the January inspection and pruned only. Two of the palms were torched, and the other, with only a single scale, was pruned. In April the entire garden was again inspected and two infested palms were found. Both of these had only single scales, and one was the palm that had been pruned after the last inspection. One of these palms was torched and the other pruned lightly. A spot inspection in May disclosed four infested palms. Three with single scales were pruned and the other, on which five scales had been found, was torched. Three infested palms were found in an inspection of the entire garden in July. One palm, which had been previously torched, had only a single dead scale on a burned leaf stub. Another had only one scale and was pruned. The third had a few scales on each of two leaves and was torched. A spot inspection in August revealed four lightly infested palms, one of which had been pruned. All four were pruned pending the harvest of the fruit. A reinspection of the spot with a different crew revealed two more lightly infested palms. One was pruned pending the removal of the fruit, and the other was torched and the offshoots were cut off and destroyed. In September the entire garden was inspected and one lightly infested palm was found and pruned. All the infested palms found in August and September which had been pruned pending the harvesting of the fruit were defoliated and torched on November 10.

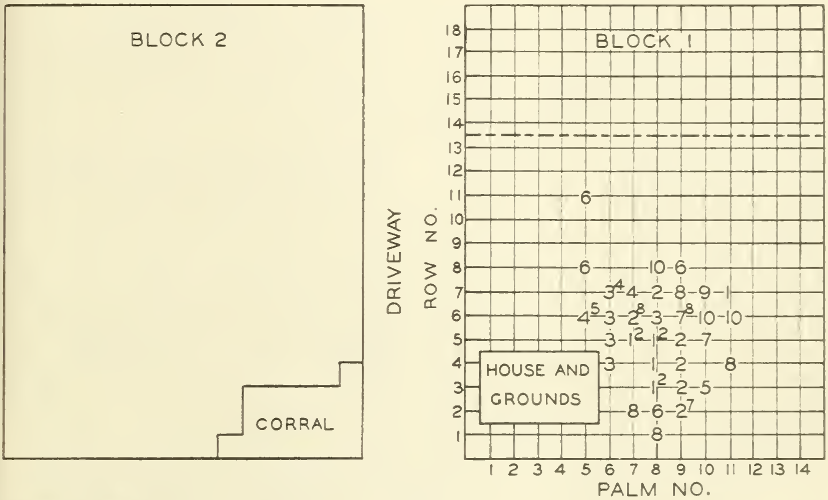

FIGURE 32.—Map of the Boyer date garden, 499 palms, Indio, Calif., showing infested palms on the following inspection dates: *1*, August 9, 1929; *2*, October 26; *3*, January 6, 1930; *4*, February 15; *5*, April 23; *6*, May 16; *7*, July 10; *8*, August 11; *9*, September 23; and *10*, November 10. Broken line shows where block 1 was marked off for spot inspection.

Beginning November 10 a spot inspection was made, and three lightly infested palms were found. These were torched. A spot inspection in December revealed no scale.

During 1931 the entire garden was inspected five times and two spot inspections were made. No scale was found. In 1932 the entire garden was inspected four times and no scale was found. The garden was inspected twice from the ground in 1933, no ladders being used, and no scale was found. In 1933 all the leaf bases were removed from the palms that had been torched. In January 1934 the entire garden was inspected from the ground and by ladder and in September 1934 from the ground, completing the inspection of the property.

During the course of eradication work in this garden 41 palm infestations were recorded, 8 of these being recurrences. Seven of the recurrences were on palms that had been pruned, and one was a dead scale on a previously torched palm. In all, 33 palms were infested, 26 of which were cleaned by torching and 6 by pruning, and 1, of little or no value, was dug out and destroyed. It is believed that after the heavily infested palm was found and torched in August 1929 there was little, if any, further spread.

Offshoots had been moved from this property to other properties before the infestation was found. These were kept under observation. No offshoots were moved after the planting had been found infested until May 1931, when a number from the noninfested part of the garden were certified for local movement. Four were certified for movement outside the eradication area. These were for experimental use and were "heat-treated" by Dr. Stickney. Many offshoots were cut for planting in nursery on the property while the garden was showing scale. All offshoots cut were carefully inspected at the time of cutting and when they left the garden. Those planted in the infested area were inspected periodically in the field during the course of the project.

Little clean-up or survey work was necessary on this property. Some pruning was done occasionally, however, to facilitate inspection, and the property was carefully scouted for small volunteer palms.

The origin of this infestation is problematic. The map of the garden and the history of the infestation indicate that there was one originally infested palm and that the infestations on the other palms resulted from spread from it. The heavy infestation that was presumably the source of most of the infestations in the Indio district, on the Banks property, was about 2 miles distant. Approximately 1 mile from the Boyer property, however, was a property on which some small, heavily infested palms had been found. From the location of the infested gardens in the district and the infested palms in the gardens, as well as the types of these infestations, it seemed possible that the Boyer infestation came from the Banks property. The Boyer palm was one of a number of palms over the district lightly infested in 1927. Judging from the build-up of the scale on other palms, it seemed probable that the Boyer palm was lightly infested in 1927 and that the infestation increased to a point of spread in 1928.

Holmes Garden, Block 3

Block 3 of the Holmes garden (fig. 33), at Indio, illustrates the garden-to-garden spread of the scale, as well as the difficulty encountered with unpruned palms bushy with offshoots. This is a block of large palms and is in one of the early gardens. This garden was planted with infested offshoots of the early importations and infested palms from the Imperial Valley. The infestation persisted until late in 1926, when from all indications the garden was free from scale. It was still inspected regularly in 1927, but no scale was observed until November, when 11 lightly infested palms, 2 of them in block 3, were found. The finding of this scale indicated that there was an undiscovered heavy infestation in the vicinity. In December a group of 27 heavily infested seedling palms were found on the Banks property, about a mile away, and other lighter infestations were found in the Indio district within 1½ miles of the Banks infestation. The heavily infested palms were eliminated when found.

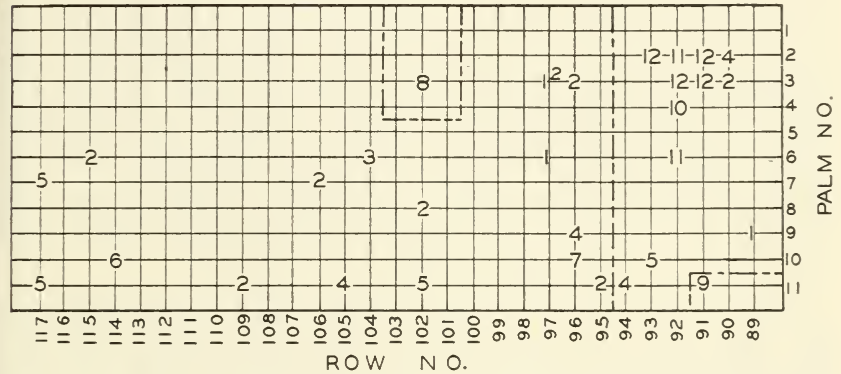

Figure 33.—Map of block 3 of Holmes date garden, 303 palms, Indio, Calif., showing infested palms on the following inspection dates: *1*, November 12, 1927; *2*, January 23, 1928; *3*, March 5; *4*, July 2; *5*, July 27; *6*, September 22; *7*, November 22; *8*, March 1, 1929; *9*, February 4, 1930; *10*, March 25; *11*, July 14; and *12*, September 2. Broken lines show areas marked off for spot inspection.

During the inspections in November 1927 and January and March 1928, 12 very lightly infested palms were found. On 6 of the 12 palms single scales were found. Five of those with single scales were pruned, and the other palms were torched. One of the palms showing a single scale in January had been found to contain 1 scale in November. This infestation was the only recurrence in the block. An inspection beginning on July 2 disclosed 4 infested palms, and because of the number found in the garden as a whole another inspection was begun on July 27. Four more infested palms were found. Inspections were made in September and November 1928, 1 infested palm being reported at each inspection. The palms found from July to November were comparatively lightly infested, but there were considerably more scales on them than on those found previously. Furthermore, many immature scales were noticed. All but 1 of these palms were torched. One with a few scales on a low leaf was pruned. During the first inspection in 1929, in March, 1 palm was found lightly infested and torched. No infested palms were reported during 4 other inspections that year.

In February 1930 two spots were inspected, one in the southeast corner of the block and the other in the north-central part of the block (fig. 33). One palm was found lightly infested and was torched. In March 1930 the entire block was inspected and one palm with considerable scale was located. This was one of several bushy palms in the northeast section of the block. These palms were varieties in which the owner was not interested and were not pollinated or pruned. The offshoots had not been removed or pruned, and the palms were very difficult to inspect. The infested palm had been pruned to facilitate inspection before the scale was found. In the July inspection of the block two more infested palms were located, each two palms distant from the one found infested in March. These were also moderately infested. Spot inspection of the six east rows in the block in September disclosed four infested palms (fig. 33). One was moderately infested, and on the others only single scales were found. The first was torched and the other three were pruned. These were the last infested palms found in block 3. In November 1930 a spot inspection was made. In 1931 the entire block was inspected four times and two spot inspections were made. In 1932 the entire block was inspected three times, and in 1933 leaf bases were removed from palms found infested during the period 1927–30 and an inspection was made from the ground. In February a final inspection of the block was made.

In 1927 the scale was apparently being carried into the garden by the wind. No more scale came from outside the garden after the Banks property had been cleaned up. Through the winter of 1927–28 the scale increased very little, and in November 1927 and January and March 1928 only very light infestations were located. The scale on the undiscovered infested palms was building up during the summer of 1928, and more infested palms with more scale were found from July 1928 to March 1929. No scale was found from March 1929 to February 1930, for all the original infestations on well-pruned palms had been found. The pruning of a group of bushy palms made it possible to locate infested palms hitherto undiscovered. There was probably some spread from the palms found moderately infested in 1930.

A total of 30 palms were found infested in block 3 during the course of the work, 21 of which were cleaned up by torching and 9 by pruning.

MIDDLETON GARDEN

The Boyer garden and block 3 of the Holmes garden were both comparatively light infestations. The Middleton garden, in which a much larger proportion of the palms were infested, was cleaned up in approximately the same time. A summary of the records is as follows:

Planting, July 24, 1929

Number of palms 10 years old or older	171
Number of palms 5 to 9 years old	9
Number of palms 1 to 4 years old	507
Total	687

Inspection date	Palms infested	Inspection date	Palms infested	Inspection date	Palms infested
1929:	*Number*	1930—Continued	*Number*	1931—Continued	*Number*
July	31	June	5	March	0
October	127	August	6	May	[1] 1
1930:		September	0	July	0
January	17	November	1	September	1
February	11	1931:		November	0
April	8	January	0		

[1] 1 dead scale only was found.

The scales on the infested palm found in September 1931 were on an inside offshoot leaf near the trunk of the parent palm. This was the last infested palm found in the garden. Four inspections from the ground and from ladders were made in 1932. One inspection from the ground only and 1 from the ground and ladders were made in 1933. One inspection from the ground only was made in 1934. A total of 606 palms were pruned in 1935. From 1 to 5 rounds of leaves were removed and inspected after removal, and the garden was inspected from the ground and from ladders after the pruning.

Abandoned Seedling Planting

In an abandoned planting 13 unthinned rows of seedling palms forming a dense growth were found infested in July 1930. The inspection conditions were very poor, and the planting was heavily infested before it was discovered. Permission was obtained from the owner to dig out most of the palms and prune up the remainder so that they could be readily inspected. A total of 1,454 palms were dug out, and 296 of the best-looking ones were left. Those left were pruned and most of the offshoots removed. The palms were inspected at intervals, and 40 of them were found infested; 35 of those infested were dug out and the remainder torched. Permission was then received to dig out all but 30, which were to be kept on a prospective building site. The 30 palms were pruned well and the leaf bases removed in March 1934. The last scale was found in the planting in November 1931, and the last inspection was made in December 1934. After the first digging in 1930 the property was scouted at intervals and all volunteer palms removed. The last check-up of the property for unlisted palms was made in January 1936.

PROGRESS IN ERADICATION, JANUARY 1, 1928, TO JUNE 30, 1936

In 1928 a rapid survey of the date-growing areas was made and eradication work in the known infested plantings was pursued as vigorously as the number of inspectors would permit. A limited amount of inspection was carried on in noninfested plantings in the infested areas. All plantings were located on maps and infested areas were designated. Plantings were listed for inspection and clean-up work.

In the Coachella Valley 2,074 infested palms were found on 38 properties during the year. Eighteen of these properties had no previous record of infestation. Thirteen of the new infested properties were lots in the town of Indio, on which 18 infested ornamental date palms were found. Two were abandoned seedling plantings, heavily infested and potential centers of spread, one with 1,484 palms and the other approximately 200. All but 83 palms of the former were dug out and all but 6 of the latter. The other 3 new infested properties were 2 small commercial gardens of standard palms and a commercial seedling planting of 1,066 palms. On 2 of these properties 6 infested palms were found and on the other only 1, which were probably infested from the centers of spread found in 1927.

In the Imperial Valley 1,077 infested palms were found on 32 properties. Eight of these had been infested previously, but there was no record of scale having been found on the remaining 24. One of the new infested properties was a seedling garden of 804 large palms generally infested. Two were small standard plantings recently set, one of 23 palms, all of which were infested, and the other of 45 palms, 2 of which were infested. Another was the Williams garden, a standard planting of 329 palms established in 1915, in which 1 infested palm was found. Eight were town lots in Holtville and El Centro, and the others were small seedling plantings on farms. All the palms were ornamentals or in family gardens and many of them were heavily infested.

In the Salt River Valley 21 infested palms were found on 6 properties. All but 1 of the properties had previous records of infestation.

In the city of Yuma four infested palms were found on four properties and two of the four properties had been infested previously.

At the beginning of 1929, with adequate funds available, the inspection force was built up as rapidly as possible, careful systematic inspection was begun in the infested areas, and more intensive work was carried on in the infested plantings. Digging out abandoned seedling palms in the infested areas was also begun.

In the Coachella Valley 588 infested palms were found on 35 properties. Eighteen were new infested properties, 11 of these being commercial gardens of standard palms ranging in size from 38 to 3,088 palms. Four were abandoned seedling plantings of 18 to 4,500 palms, and the remaining 3 were ornamental plantings on city lots in Palm Springs and Indio. One of the seedling plantings was heavily infested, but because of the size of the palms, its situation in the brush, and location in regard to other plantings, not much spread was anticipated.

In the Imperial Valley 164 infested palms were found on 49 properties, 31 of the properties being without previous record of infestation. All the new infested properties were small dooryard plantings.

In the Salt River Valley 49 infested palms were found in 9 dooryard plantings, 5 not having been reported as infested.

At Yuma three infested palms were found on two properties previously infested.

In 1930 systematic inspection with an adequate force of experienced inspectors was under way. Survey inspection in outside areas and systematic fan and Canary Island palm inspection in infested areas were begun. Digging abandoned palms or cleaning away the brush and pruning them where permission could not be obtained for digging was continued.

In the Coachella Valley 230 infested palms on 21 properties were found. This total includes 44 fan palms found near a heavily infested date palm. Five of the properties had not been previously reported as infested. One of the new infested properties was an old seedling garden that had been subdivided and sold. It was abandoned and so overgrown with mesquite and brush that the palms could not be inspected. Permission had been obtained to dig most of the palms, and scale was found when the palms were dug. There were 1,308 palms in the planting. Another was a heavily infested seedling planting with a total of 1,750 palms in 13 unthinned rows. A third was a group of 12 heavily infested seedling palms planted close together in the town of Thermal. The remaining new infested properties were a standard garden of 190 palms, only 1 of which was infested, and a seedling planting of 179 palms, only 1 of which was infested.

In the Imperial Valley 89 infested palms were found on 25 properties. Eleven of the properties had not been reported as infested. These were all dooryard or roadside plantings, the largest planting containing 195 palms. Scale was found in both the Reid and Williams gardens during the year. No scale had been found in the Reid garden since 1927. It was established in 1915.

In the Salt River Valley 63 infested palms, including 50 fan palms, were found on 5 properties, 1 property not having been recorded as infested. All were dooryard plantings.

In Yuma seven infested palms were found on three properties. Four of the infested palms were date palms, and three were fan palms. All properties had been previously infested.

In 1931 systematic inspection was continued in the eradication areas and survey inspection in outside desert areas, including the Palo Verde Valley and Death Valley in California. A little survey work was also done in the California citrus belt. Intensive surveys (section by section) were begun in the infested areas. The first fan palm inspections in the Coachella Valley and the Salt River Valley were completed. Fan and Canary Island palm inspection was continued in the Imperial Valley.

In the Coachella Valley 17 infested palms were found on 4 properties. No new infestations were recorded.

In the Imperial Valley 26 infested palms were found on 11 properties, 2 of the properties not having been reported as infested. Six of the palms were fan palms and 2 were Canary Island palms. Only 1 dead scale was found in the Williams garden and none in the Reid garden during the year.

No scale was found in Arizona during the year.

In 1932 systematic inspection was continued in the infested areas. Inspections were made in the noninfested areas and many of the plantings were dropped from the inspection lists. The first section-by-section surveys in the infested areas in the Coachella Valley and Imperial Valley were completed. Canary Island and fan palm inspection was continued in the Imperial Valley. The Tucson section and other sections outside the eradication areas in Arizona were scouted. A survey inspection of the Rio Grande Valley in cooperation with the Texas Department of Agriculture was also made.

In the Coachella Valley no scale was found during the year. In the Imperial Valley 43 infested palms were found on 6 properties. Two of the properties had no previous record of infestation. Four of the palms were fan palms on a property where a heavily infested date palm had previously been dug out. Thirty-six were Canary Island palms, lining a drive in a cemetery. This was a new infested property. Some of these palms were heavily infested. Scale was found on a date palm within a mile of the Canary Island palms. This also was a new infested property. The remaining 2 palms were on old infested properties, a single scale having been found on each palm. One infested palm was located on an old infested property in the Salt River Valley. The palm had been treated in 1927, and evidently the scale persisted on the leaf bases. The palm was destroyed. No infested palms were found in the Yuma Valley.

In 1933 less frequent inspections were made and ladders were used only in certain gardens. Leaf bases were removed from old infested palms to be sure no infestations remained which could not be located by ordinary inspection. The section-by-section survey in the Salt River Valley was completed. In the Imperial Valley a large area was resurveyed for unlisted palms.

No scale was found during the year in the Coachella Valley or in Arizona. In the Imperial Valley 10 infested palms were found on 4 properties, all having been previously infested. A Canary Island palm was found near infested date palms. Seven infested date palms were found in the Reid garden. Only a single dead scale was recorded in this garden from November 1930 until July 1933. One palm in this garden was found moderately infested in July. Six nearby palms were lightly infested. Careful examination of the moderately infested palm showed no leaf-base infestation; so it is probable that the infestation came from an outside source. The territory within 2 miles of the garden was carefully scouted several times for unlisted palms. The heavily infested palms in the cemetery 2 miles distant were the most likely source of the scale. It is possible, however, that the scale was overlooked for nearly 2 years, for only ground inspection was carried on in the garden from October 1931 to July 1933. One of the remaining palms was in a neglected planting which was previously infested and the other was an offshoot growing from a buried stump on a canal bank. The property had been infested in 1923 or 1924 and all the palms were supposed to have been destroyed at that time. The offshoot was found during the section-by-section resurvey.

In 1934 additional plantings were dropped from the inspection lists, and in certain districts only ground inspection and survey work was carried on. Inspection in certain gardens from ground and ladders was continued. All properties previously infested were checked for volunteer palms, and all previously infested palms were dug if permission of the owners could be obtained or, if such permission was not granted, the leaf bases were removed where it seemed necessary. Pruning was carried on in many plantings to insure that the final inspection would be effective. The final inspection of standard palms in the Casa Grande Valley, Fort Mohave, Topock, and other localities in Arizona outside the eradication areas was made. Pruning and leaf-base work was completed in the Salt River Valley and most palms were given final inspection. No scale was found in the Coachella Valley or in Arizona. In the Imperial Valley only three lightly infested palms were recorded; these were found in the Reid garden in February.

In 1935 only a few plantings were inspected from the ground and from ladders. Most of the inspections were from the ground only. Clean-up work and the final inspection in the infested areas were completed in Arizona in August. A final fan palm inspection was made in the Coachella Valley and pruning and inspection were carried on in certain previously infested gardens. Practically all inspection work was completed in the Coachella Valley. In the Imperial Valley the final inspection of fan and Canary Island palms and survey work were completed. Pruning and leaf-base work were done preliminary to the final inspections.

No scale was found in 1935.

In May 1936 all eradication work was completed in the Coachella Valley. In the Imperial Valley the Reid garden was given final inspection in February. In March leaf bases were removed from all the palms in the garden that were infested after 1927. Pruning and inspection were continued in the Imperial Valley until June, when the project was closed.

No scale was found in 1936.

SUMMARY

Date palms have been grown from seed in the Southwest since the establishment of the Missions, but it was not until 1890 that the first successful importation of offshoots from the Old World was made. In that year 68 date palm offshoots were imported by the Division of Pomology of the United States Department of Agriculture and distributed to cooperators in the Southwest. During the period 1900–23 about 50,000 offshoots were imported for experimental and commercial plantings.

Offshoots of the first importation were infested with the parlatoria date scale, and an effort was made to eliminate the insect by spraying with a kerosene and soap emulsion before the offshoots were sent to the cooperators. The effort was apparently successful, but about 2 years later the scale was found on the nine palms that had been sent to Arizona. Spraying with the materials available at that time and fumigation with hydrogen cyanide were carried on persistently, but the scale was not eliminated and was spreading to nearby seedling plantings. Many offshooots in later importations were also infested.

In 1905 the scale was observed on the leaf bases of the palm, well protected by bands of fiber. It was found that by defoliating the palm, removing the leaf bases, and applying the flame of a gasoline torch to the bole the scale could be eliminated.

Using this method, the Arizona Agricultural Experiment Station began a campaign in 1907 to eradicate the scale in Arizona. In 1909 that State appointed a horticultural commission, which was authorized to make regulations governing the entry of plants to prevent the introduction of insect pests, to control the insects already established, and to hire qualified men to enforce the regulations.

The Federal Plant Quarantine Act was approved on August 20, 1912, and in 1913 a Federal Notice of Quarantine (No. 6) was promulgated defining the areas known to be infested with the parlatoria date scale and the red date scale, and regulations were made for the interstate movement of date palms and offshoots.

The eradication work by the Federal Horticultural Board in cooperation with other interested agencies was carried on vigorously, and by the end of 1927 the scale had apparently been eradicated in the originally infested plantings. In the meantime, however, the insect had spread to seedling plantings, which in time became centers of spread. An insufficient number of inspectors made it impossible to meet the situation created by the infestations outside the original plantings and the increased acreage and size of palms.

In December 1927 additional funds were provided for a survey of the date-growing area and a study of the problem, and in 1928 the first survey of the date-growing area was made. The main objectives were to determine the approximate number of date palms in that area and to locate centers of spread. The inspection was cursory. Intensive eradication work in the known infested plantings was also carried on in 1928, and the centers of spread discovered in the survey were promptly eliminated as such. The survey indicated that eradication was feasible if adequate funds were available.

The funds were provided jointly by the Federal Government and the States of Arizona and California, and in 1929 a reorganized campaign was begun. The general program adopted was as follows: (1) Survey and inspection to determine the infested areas, (2) clean-up work to get all date palms in condition for adequate inspection, (3) systematic inspection to locate infested palms, and (4) treatment to eradicate the scale on the palms found infested. In general, the inspection and treatment procedure that had been developed during the course of the work was used.

In 1929 the inspection force was increased and, with clean-up work and more intensive inspection, many new infestations were found. During the following 2 years systematic survey, inspection, and clean-up were continued with a full force of inspectors. Beginning in 1932 eradication areas were reduced in extent, reduction in the inspection force was begun, and the work in the infested areas was intensified. This procedure was continued until June 30, 1936, when the project was closed. The progress made in eradicating infested palms each year will be seen in table 2.

TABLE 2.—*Annual progress made in eradication of infested palms in the date-growing area of the Southwestern States from 1928 to June 30, 1936*

Year	Total infested properties	New infested properties	Infested palms	Year	Total infested properties	New infested properties	Infested palms
	Number	*Number*	*Number*		*Number*	*Number*	*Number*
1928	80	45	3,176	1933	4	0	10
1929	95	54	804	1934	1	0	3
1930	54	17	389	1935	0	0	0
1931	15	2	43	1936 (6 months)	0	0	0
1932	7	2	44				

Before any conclusion is drawn concerning the present status of the parlatoria date scale in the United States, the possibility that the scale became permanently established outside the date-growing area must be considered. In view of the history of the introduction of date palm offshoots and the development of the industry, such a result does not seem probable. Furthermore, there seems less probability that the scale, if so established, would be reintroduced into the date-growing area. It is also possible that infested palms were overlooked in the date-growing area; but in view of the scouting work done, this does not seem probable.

Although there is no proof that the parlatoria date scale has been eliminated, owing to the limitations of inspection and survey, the evidence definitely indicates that this scale has been eradicated in the United States.

LITERATURE CITED

(1) COCKERELL, T. D. A.
1895. NEW SCALE-INSECTS FROM ARIZONA. *In* Toumey, J. W., Notes on Scale Insects in Arizona. Ariz. Agr. Expt. Sta. Bul. 14: 56.

(2) ———
1899. A DATE-PALM SCALE INSECT. Science 9: 417.

(3) ———
1899. SOME NOTES ON COCCIDAE. Acad. Nat. Sci. Phila. Proc. 1899: 259–275.

(4) ———
1907. THE SCALE INSECTS OF THE DATE PALM. Ariz. Agr. Expt. Sta. Bul. 56: [185]–192, illus.

(5) FORBES, R. H.
1907. THE EXTERMINATION OF DATE-PALM SCALES. Ariz. Agr. Expt. Sta. Bul. 56: [193]–207, illus.

(6) MORRILL, A. W.
1910. REPORT OF THE ENTOMOLOGIST OF THE ARIZONA HORTICULTURAL COMMISSION FOR THE YEAR ENDING JUNE 29, 1910. Ariz. Comn. Agr. and Hort. Ann. Rpt. 2: [8]–15.

(7) ———
1912. REPORT OF THE ENTOMOLOGIST OF THE ARIZONA HORTICULTURAL COMMISSION FOR THE YEAR ENDING JUNE 30, 1912. Ariz. Comn. Agr. and Hort. Ann. Rpt. 4: [15]–43, illus.

(8) QUAYLE, H. J.
1916. DISPERSION OF SCALE INSECTS BY THE WIND. Jour. Econ. Ent. 9: 486–493, illus.

(9) SHAMBLIN, A. J.
1924. ERADICATION AND CONTROL OF DATE SCALE. Date Growers' Inst. Rpt. 1: 13–14.

(10) STICKNEY, F. S.
1934. THE EXTERNAL ANATOMY OF THE PARLATORIA DATE SCALE, PARLATORIA BLANCHARDI TARGIONI TOZZETTI, WITH STUDIES OF THE HEAD SKELETON AND ASSOCIATED PARTS. U. S. Dept. Agr. Tech. Bul. 421, 68 pp., illus.

(11) TARGIONI TOZZETTI, AD.
1892. AONIDIA BLANCHARDI, NOUVELLE ESPÈCE DE COCHENILLE DU DATTIER DU SAHARA. Soc. Zool. de France, Mém. 5: 69–82, illus.

(12) TOUMEY, J. W.
1898. THE DATE PALM. Ariz. Agr. Expt. Sta. Bul. 29: [102]–150, illus.

(13) TRAUB, HAMILTON P., and ROBINSON, T. RALPH.
1937. IMPROVEMENT OF SUBTROPICAL FRUITS OTHER THAN CITRUS. U. S. Dept. Agr. Yearbook Separate 1589, 77 pp. illus.

(14) UNITED STATES DEPARTMENT OF AGRICULTURE, DIVISION OF ENTOMOLOGY.
1891. EXPERIMENTS WITH A DATE-PALM SCALE. U. S. Dept. Agr., Div. Ent. Insect Life 3: 441–443.

(15) UNITED STATES DEPARTMENT OF AGRICULTURE, FEDERAL HORTICULTURAL BOARD.
1913. DATE-PALM SCALE INSECTS. U. S. Dept. Agr. Notice Quar. 6 (Dom.), 3 pp.

U. S. GOVERNMENT PRINTING OFFICE: 1941

For Sale by the Superintendent of Documents, Washington, D. C. Price 10 cents.

6/4